A CLASSIFICATORY STUDY OF PHONEMIC SYSTEMS IN AUSTRALIAN ABORIGINAL LANGUAGES

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This thesis is the original work of the author unless otherwise acknowledged.

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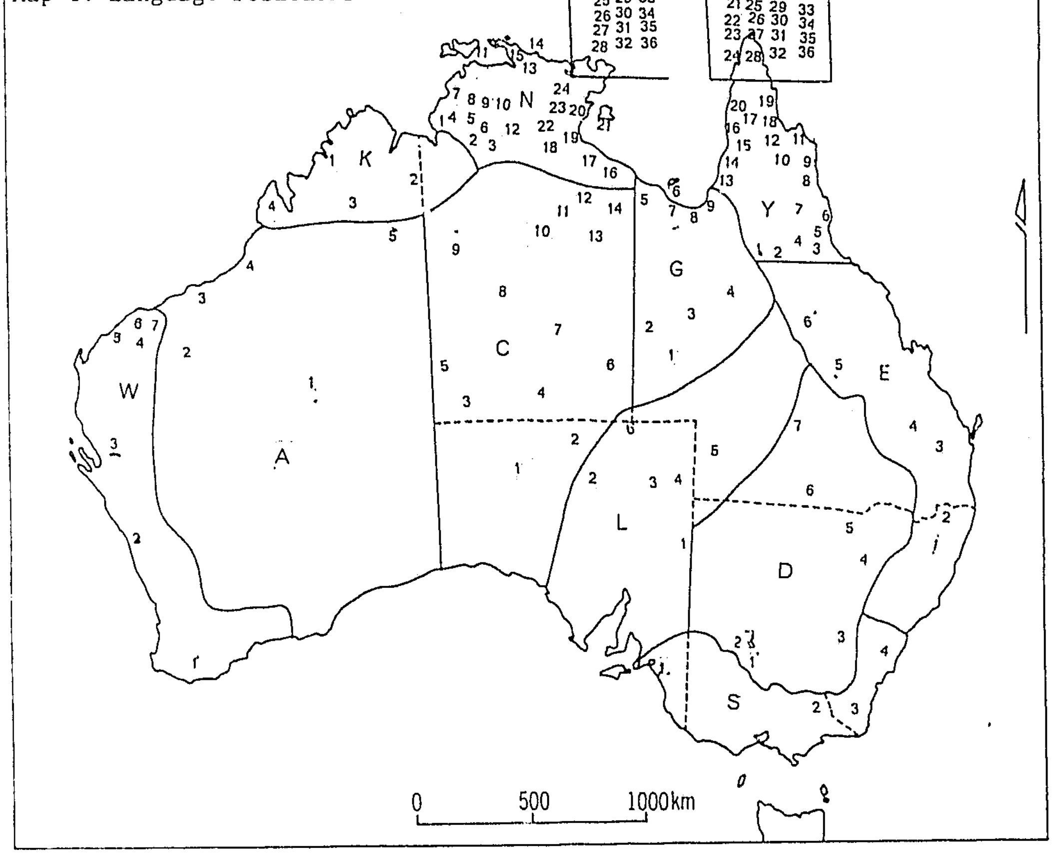

Map 1 above gives the approximate locations of the languages studied. I have used the same area coding as the A.I.A.S. Tribal Bibliography. The languages and their respective numbers are as follows. Note that this numbering system is the same throughout the areal distribution maps of Appendix 1.

AREA S

1 Yaraldi
2 Ngarigu
3 Dhurga
4 Dharawal

AREA D

1 Wemba-wemba
2 Madi-madi
3 Ngiyamba
4 Nganjaywana
5 Yuwaalaraay
6 Murawari
7 Margany

AREA E

1 Waalubal
2 Gidabal
3 Waka-waka
4 Gureng-gureng
5 Gungabula
6 Bidyara

AREA Y

1 Mbara
2 Warungu
3 Wargamay
4 Gugu-Badhun
5 Dyirbal
6 Yidiny
7 Mbabaram
8 Djaabugay
9 Gugu-Yalanji
10 Mulurudji
11 Guugu-Yimidhirr
12 Kuku-Thaypan
13 Gog-Nar
14 Koko-Bera
15 Kunjen
16 Yir-Yoront
17 Thaayore
18 Lama-lama
19 Umbuygamu
20 Wikmunkan
21 Wik-Ep
22 Umbila
23 Yinwum
24 Kuuku-Ya?u
25 Ludigh
26 Wikmumin
27 Ndra?angid
28 Awngdim
29 Aridingidigh
30 Nggod
31 Lenngidigh
32 Mpakwithi
33 Mbalidjan
34 Mbeiwum
35 Yathaikana
36 Mabuiag

AREA L

1 Malyangapa
2 Arabana
3 Diyari
4 Yandruwandha
5 Wanggumara
6 Wangganguru

AREA K

1 Ngarinjin
2 Kitja
3 Djaru
4 Bard

AREA N

1	Murinbata	13	Gunwinggu	25	Ritharngu
2	Djamindjung	14	Maung	26	Burera
3	Waḍaman	15	Yiwadja	27	Djeebana
4	Ngangikurrungurr	16	Garawa	28	Yanhangu
5	Maranunggu	17	Yanyula	29	Djambarrpuynggu
6	Ngengomeri	18	Alawa	30	Gubabuyngu
7	Brinken	19	Mara	31	Wangurri
8	Wadyiginy	20	Nunggubuyu	32	Warramiri
9	Pungu-pungu	21	Andiljaugwa	33	Djabu
10	Malag-malag	22	Dalabon	34	Galpu
11	Tiwi	23	Rembarnga	35	Datiway
12	Mayali	24	Wagilak	36	Mandelbingu

AREA A

1	Mantjiltjara	3	Nyangumarda	5	Walmatjari
2	Bailko	4	Garadjari		

AREA C

1	Gugada	6	Andegeribina	11	Djingili
2	Andagerinja	7	Alyawarra	12	Ngarndji
3	Pitjantjatjara	8	Kaititj	13	Wambaya
4	Aranda	9	Walpiri	14	Gudandji
5	Pintupi	10	Waramunga		

AREA G

1	Pita-pita	4	Ngawun	7	Kukatj
2	Waḷuwara	5	Yukulta	8	Kuthant
3	Kalkatungu	6	Lardil	9	Kurtjar

AREA W

1	NjungaR	4	Yinytyiparnti	6	Ngaḷuma
2	Nanta	5	Kurama	7	Ngarla
3	Thargari				

INTRODUCTION

This classificatory study of phonemic systems is an attempt to provide an understanding of the structures and characteristics of the phonologies of Australian aboriginal languages. In order to classify the phonological systems we need to survey the languages and determine the types of systems that do occur. We also need to examine the acoustic structure of some phonetic characteristics of the phonemes that make up these systems. Finally, the classification of phonemic types into systems involves an examination of distinctive feature systems and their applicability to the Australian situation.

The first section surveys 134 languages from the total of approximately 260 said to occur on the continent (Wurm, 1972 : 9). We need to note the phonemes recorded in language descriptions and their distributions, both systemic and areal. General language surveys consisting of a single chapter or short article capture some of the more obvious generalizations that can be said of Australian phonological systems. With the exceptions of Dixon (1970b, 1972, forthcoming a) and Wurm (1972) for instance, there have been no systematic attempts to describe the nature and significance of these generalizations.

Once having specified the types of phonemes and their distribution we turn to the acoustic study of some of the more pertinent phonetic, or segmental, characteristics; for example, Australian languages can have a maximum of seven positions of articulation for stops and nasals, excluding the glottal stop. The analysis examines aspects of segments which can be seen as some of the distinguishing parameters necessary for distinctions. Two excellent studies of aboriginal languages serve as an important contribution to the knowledge of acoustic structures of these languages: Trefry's (1974) description of Diyari and McDonald's (1977) Yaraldi analysis. Jernudd's (1974) palatographic analysis of Gunwinggu phonemes provides articulatory evidence on the positions of articulation in Australian languages.

The third and final section examines the relative abilities of distinctive feature systems[1] to distinguish aboriginal phonological systems in light of the distribution of phonemes and their phonetic characteristics. In the development of universal distinctive features, little attention has been given to Australian languages. Chomsky and Halle mention only one Australian language, Aranda (Chomsky-Halle, 1968 : 312); Ladefoged mentions none. On the other hand, contrasted with these universally orientated systems, is Dixon's feature inventory, a system that is uniquely Australian in that it captures generalizations which are characteristic of aboriginal phonological organization.

The consequence of such an examination is the development of a feature system which is both capable of making the characteristic phonological distinctions and has regard for the acoustic structure of the phonetic realizations.

1. The feature systems of Jakobson-Halle, Chomsky-Halle, Ladefoged, Fant and Dixon are examined.

1.0. DISTRIBUTIONAL ANALYSIS OF PHONEMIC SYSTEMS

In the analysis of phonological systems of Australian aboriginal languages we need to examine the types of phonemes that constitute a phonological system and the contrasting characteristics of the systemic arrangements. In the analysis that follows we find that a large array of phonemes fall into a small discrete set of arrangements.

The approach adopted looks at the types of position of articulation arrangements within manner of articulation classes. Of all the possible combinations that are permutable in each class of sounds we find that only a small number are ever realized. For example, we do not find the stop arrangement of /b d ḍ g/ for the only 4 - stop position arrangement occurring in Australian languages is /b d d^y g/. Therefore, this method of analysis will enable us to specify the distributional patterns that occur in the phonologies of Australia.

We can also examine the areal distributions of these distributional patterns, and it should be noted that areal congruence is equally important as is areal diversity, for both can suggest diachronic development and synchronic relations. In Appendix 1 we find the areal distributions that correspond to the systemic arrangements.

1.1.0. CONSONANT PHONEMES

Table 1 below is a listing of the consonants that have been recorded in the languages studied. The horizontal arrangement of positions of articulation reflects the preferred emphasis on the active articulator rather than the passive place of articulation[2] (Dixon,

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2. The merits of such an arrangement are discussed in 3.1.1.4. and 3.4.1.1.

forthcoming a : 20). The vertical arrangement of manners of articulation represents the order of the analysis in the following sections.

TABLE 1: CONSONANT PHONEMES

	Apical		Laminal		Peripheral			Glottal
	Alveolar	Retroflex	Dental	Palatal	Bilabial	Velar	Palato-velar	
stops	d	ḍ	d̪	d^y	b	g	gj	ʔ
2nd series stops	t	ṭ	t̪	t^y	p	k		
Prenasalized stops	nd	ṇḍ	n̪d̪	n^yd^y	mb	ŋg	ŋjgj	
nasals	n	ṇ	n̪	n^y	m	ŋ	ŋj	
laterals	ℓ	ḷ	ℓ̪	ℓ^y				
Prestopped nasals	N	Ṇ	N̪	N^y	M	Ŋ		
Prestopped laterals	L	Ḷ	L̪	L^y				
Prepalatalized	$^yd/^yn$ $^yN/^y\ell$							
rhotic release								
stops	d^r	ḍ^r						
prenasals	nd^r							
Labialized								
stops	d^w	ḍ^w			b^w	g^w		
prenasals	nd^w			n^yd^{yw}	mb^w	ŋg^w		
nasals	n^w				m^w	ŋ^w		
prestopped nasals					M^w	Ŋ^w		
laterals		ḷ^w						
rhotics								
flap	r							
trill	ř							
Glided rhotics	ɹ	R						
Glides			y̪	y	w/ẅ			
Fricatives	s/z		ð	ʒ	β	ɣ		

The tabular representation given is also indicative of the sound represented by the symbol employed with the following exceptions. The choice of the voiced symbols for the stop series and the voiceless symbols for the second stop series does not necessarily indicate the true nature of the distinction in any languages (cf. 1.1.3. below). It is a device which reflects a marking phenomenon in Australian linguistics, for it is the normal practice for single stop series languages to be represented by either set of symbols. Some linguists prefer the voiceless symbol, others the voiced. The voiced symbols are used throughout this thesis for languages with no contrast between the two manners of stop production, the voiceless symbols are used when a contrast is present. In language names the presence of voiceless symbols does not automatically indicate the presence of a second series of stops but is rather the preference of the linguist or an idiosyncrasy of mine. For example, Kalkatungu is a single series stop language, but Blake (1969) uses this representation with the voiceless symbols and I follow suit. Some modifications to language names have been made for ease of orthographic representation.

The use of capital letters to represent phonemes is restricted to prestopping and rhotics, and is an orthographic standardization indicating this phenomenon discussed in 1.1.7. and 1.1.11. below.

It could be argued that those sounds represented by two symbols, like prenasalized stops, prepalatals and labialized consonants could perhaps be better treated as clusters. However, for the purpose of systematic analysis author preference has been overlooked. Take for example, prenasalized stops. Burera has initial homorganic nasal and stop clusters which are treated as such (Glasgow, D & K, 1962 : 10); Alawa is recorded as having prenasalized stops (Sharpe, 1972 : 14).

I have treated both languages in the same manner and record them as having prenasalized stops.[3] However, in those languages where a researcher has not marked initial clusters as prenasalized stops I will indicate these by placing the word "initial" in brackets after the language name.

Finally, a question mark in brackets after a language name indicates uncertainty on the part of the researcher or myself.

1.1.1. STOP CONSONANTS

We shall exclude the glottal stop from this section (see 1.1.2. below) and examine the arrangement patterns of the seven remaining stops. The following five arrangements are found, the distributions are set out below:

b d d^y g

b d ḍ d^y g

b d d̠ d^y g

b d ḍ d̠ d^y g

b d ḍ (d̠) d^y gj g

1.1.1.1. b d d^y g (21 = 15.67%)[4]

Guugu-Yalanji	Mabuiag	Lenngidigh
Gidabal	Mulurudji	Lama-lama
Gureng-gureng	Malag-malag	Waka-waka
Djaabugay	Ngarigu	Warungu
Dyirbal	Ngengomeri	Wargamay
Tiwi	Nganjaywana	Waalubal
Maranunggu	Nyangumarda	Yidiny

3. See 1.1.4. below and my paper (1978b) for further discussion of prenasalization.

4. See next page.

It should be noted that in the single laminal languages, namely 1.1.1.1. and 1.1.1.2., some authors prefer to use the dental symbol rather than the palatal. The reason appears to rest in the allophonic alternation of the two. In Tiwi, for example, $/d^y/$ is found preceeding /i/, /d̪/ elsewhere (Osborne, 1974 : 10). Obviously the dental occurs in more environments than the palatal and thus the preferred symbol is the dental. The other languages that have preference given to the dental rather than the palatal are Mabuiag, Lama-lama, Lennigididgh and in 1.1.1.2., Madi-madi. Preference is given to uniformity and the laminal palatal symbol is employed in languages with no laminal contrast. This type of phenomenon supports the diachronic evidence on the development of two laminals from one (Dixon, 1970b : 92).

The areal distribution of the 4-stop arrangement is found on Map 1, Appendix 1. This type occurs along the east coastal regions of Australia, Cape York and the Daly River region of the Northern Territory. Only one example, Nyangumarda, is found in Western Australia. It appears that the central region is devoid of this type.[5]

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4. The number and percentage figures that occur after each arrangement indicates the number of languages having this set of stop positions. The percentage is the proportion this group occupies out of the total number of languages sampled. The same use of figures applies throughout this section.

5. It should be noted that the areal distribution covers only those languages studied. Therefore the claim of non-appearance is not absolute, but rather a suggestion of the distribution pattern of a certain phenomenon. This caveat applies throughout the study.

1.1.1.2. b d ḍ d^y g (29 = 21.64%)

Andagerinja	Gugada	NjungaR
Alawa	Djaru	Rembarnga
Burera	Djeebana	Wadyiginy
Pungu-pungu	Mayali	Walpiri
Pintupi	Mantjiltjara	Waḍaman
Bard	Madi-madi	Walmatjari
Pitjantjatjara	Mara	Waramunga
Gugandji	Maung	Wambaya
Garadjari	Ngarinjin	Yiwadja
Gunwinggu	Ngarla	

The double apical, single laminal languages are restricted to the western half of the continent. On Map 2 we see that Madi-madi is the only language that occurs east of the eastern Northern Territory - South Australian north-south border.

1.1.1.3. b d d̠ d^y g (33 = 24.63%)

Aridingidigh	Gog-Nar	Mbabaram
Awngdim	Koko-Bera	Mbeiwum
Umbila	Kuuku-Yaʔu	Mbalidjan
Umbuygamu	Kuku-Thaypan	Mpakwithi
Brinken	Guugu-Yimidhirr[6]	Mbara
Gugu-Badhun	Thaayore	Nggod
Kunjen	Dhurga	Ngangikurrungurr
Kurtjar	Dharawal	Ngiyamba

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6. John Haviland (pers. comm.) reports the possibility of retroflex stops and nasals for he found the regular occurrence of initial retroflexes in a few cases. Initial occurrence is quite significant for it is in this position that the retroflex and alveolar distinction can be neutralized, as in the case in some Mara words for example (Busby, 1978a : 3-4).

Ndra?angid	Wik-Ep	Yathaikana
Ludigh	Wikmumin	Yinwum
Wikmunkan	Yir-Yoront	Yuwaalaraay

On Map 4 we find the areal distribution of the double laminal single apical languages. They are predominantly restricted to the Cape York region, with two cases in the Daly River area: Brinken and Ngangikurrungurr. These are the only two examples west of the eastern north-south Northern Territory-South Australian borders.

1.1.1.4. b d ḍ d̠ d^y g (47 = 35.07%)

Andiljaugwa	Kitja	Nunggubuyu
Andegeribina	Djamindjung	Lardil
Alyawarra	Djabu	Ritharngu
Arabana	Djambarrpuynggu	Warramiri
Aranda	Thargari	Wangurri
Bidyara	Dalabon[7]	Wagilak
Pita-pita	Datiway	Wanggumara
Bailko	Diyari	Wangganguru
Kaititj	Malyangapa	Waḷuwara
Gubabuyngu	Murawari	Wemba-wemba
Galpu	Margany	Yanhangu
Gungabula	Murinbata	Yandruwandha
Kukatj	Mandelbingu	Yinytyiparnti
Kuthant	Ngawun	Yukulta
Kalkatungu	Ngaḷuma	Yaraldi
Kurama	Nanta	

7. Dalabon may not have a dental series. O'Grady, Voegelin C & F (1966 : 61) are uncertain of its status, whilst Capell (1962 : 93) lists them as phonemic.

The distribution of this 6-stop arrangement, Map 3, is rather scattered, with only Cape York and the east coast being exempt. Gungabula and Bidyara in Central Queensland and Murawari on the Queensland border are the most eastern occurrences. Yaraldi and Wemba-wemba are the most southern.

1.1.1.5. b d ḍ (d̲) d^y gj g (4 = 2.99%)

Djingili	Garawa
Ngarndji	Yanyula

Of these four languages only Yanyula has the full seven stops, the other three lack the dental. We can see on Map 5 that these languages are restricted to a small area west of the southern end of the Gulf of Carpentaria. Djingili and Ngarndji are in the Djingili-Wambayan language family, whilst Yanyula and Garawa do not appear to be related despite their geographical closeness. Of all four, only Yanyula is a prefixing language (Wurm, 1972 : 118-119). It is interesting to note that Gudandji, occurring between the two groups, is a double apical, single laminal language. Wambaya has the same system as Gudandji and occurs south of Djingili.

1.1.2. GLOTTAL STOP

Capell remarks that the glottal stop is found "almost exclusively in Cape York Peninsula and Arnhem Land" (Capell, 1967 : 91); with the exception of Nanta in Western Australia, this statement holds true. In the Arnhem Land languages[8] presented below, the glottal stop may be a syllable prosody (Dixon, pers. comm.), although only a few researchers have recorded it as such.

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8. The division between Arnhem Land languages and others is also made in second series stops (1.1 3. below).

1.1.2.1. Arnhem Land Languages

Gunwinggu[9]	Djambarrpuynggu	Warramiri
Galpu	Djabu	Wangurri
Gubabuyngu	Mandelbingu	Wagilak
Datiway	Ritharngu	Yanhangu
Dalabon	Rembarnga[10]	

1.1.2.2. Other Languages

Awngdim	Murinbata[11]	Lenngidigh
Umbuygamu	Maung	Lama-lama
Umbila	Nggod	Wikmunkan
Kuuku-Yaʔu	Ndraʔangid	Wik-Ep
Thaayore	Nanta (?)[12]	Yinwum
Mpakwithi	Ludigh	Yir-Yiront
Mayali		

Map 6 shows the areal distribution where we see that the one exception to Capell's observation of Nanta on the West Australian coast.

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9. The glottal stop in Gunwinggu is recorded as a syllable final prosody (Caroll, 1976 : 15).

10. Rembarnga, like Gunwinggu, is recorded with a syllable final glottal stop (McKay, 1975 : 14).

11. The glottal stop occurs in only one word in Murinbata; /muʔmun/ "water rat" (Walsh, 1976 : 25).

12. The source of the Nanta material is O'Grady, Voegelin C & F (1966 : 61) and not the result of an in-depth study. Their material varies in quality. In Aranda, for instance there is agreement with other researchers, whilst in others like Brinken, there are differences. Tryon recorded no retroflexes, no dentals except the stop, no vowel length and the possible occurrence of schwa (Tryon, 1974 : 71) in Brinken in comparison to the phonemic system given by O'Grady, Voegelin, C & F. In this instance I have used Tryon's material.

1.1.3. SECOND SERIES STOPS

In the analysis of languages under study there has been a natural division in double stop phonologies. The first of these is in Arnhem Land, represented below; the second is a more geographically diverse group. The same division is found with glottal stop occurrence (see 1.1.2. above).

For those languages with a specification following, the label indicates the choice of the researcher.

1.1.3.1. Arnhem Land Languages

These languages appear to have a distinction only in certain environments and under some morphophonemic constraints. In Mayali, the distinction is found intervocalically and after some sonorants (Merlan, pers. comm); in Galpu the situation appears to be similar (Wood, 1972 : 28).

Burera (?)[13]	Mayali [lenis/fortis]
Gubabuyngu [gem./non-gem.]	Ngangikurrungurr[15]
Galpu[14]	Rembarnga [gem./non-gem]
Djambarrpuynggu	Ritharngu [lenis/fortis]
Djabu	Wangurri
Djeebana [gem./non-gem.]	Warramiri
Datiway	Wagilak
Mandelbingu	Yanhangu

---

13. Burera is included even though the Glasgows (1962) dismiss the second series. Tryon reports them and states that their behaviour is similar to others in this group (Tryon, 1974 : 231) (note also f.n. 15 below).

14. The distinction in Galpu is reported to be fortis, voiceless, geminate/lenis, voiced, non-geminate. (Wood, 1977 : 28).

15. Ngangikurrungurr is reported as having a double stop system (Courtenay, 1976 : n.p.) on one hand, whilst on the other it has been dismissed for morphophonemic reasons (Tryon, 1974 : 231). Tryon also remarks that the same phenomenon occurs in some of his Daly River languages, and these perhaps should be included in this language group. The predictability, however, of the second series of stops is still unclear in some of the languages within the Arnhem Land group.

1.1.3.2. Other Languages

Umbuygamu [voiced/voiceless]	Mbeiwum [voiced/voiceless]
Kunjen [aspirate/non-aspirate]	Mabuiag [voiced/voiceless]
Djamindjung [voiced/voiceless][16]	Wikmumin [voiced/voiceless]
Thargari [voiced/voiceless]	Wanggumara [voiced/voiceless]
Diyari [voiced/voiceless][17]	Waramunga [gem./non gem.][19]
Murinbata [voiced/voiceless][18]	Waḷuwara [voiced/voiceless][20]
Margany [tense/lax]	Yandruwandha [voiced/voiceless]

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16. Djamindjung is like Murinbata and Ngangikurrungurr in that it lacks /d̲/ and /n̲/. Because of this peculiarity, Walsh sets up /t̲/ as a marginal phoneme, as he also does in Murinbata (Walsh, 1976 : 24 & pers. comm.).

17. Diyari has only two voiced stop phonemes, namely the apicals /d/ and /ḍ/. (Austin, 1978 : 51).

18. Refer to f.n. 15 and 16 above, and note that the distinction between the two series is not restricted to specific environments. For example we find a distinction between /bi/ "string" and /pi/ "mudfish" (Walsh, 1976 : 28), where in Ngangikurrungurr the distinction is not made word initially.

19. Hale (1959 : 1) reports $\underset{[+\text{ stop}]}{\text{C}} \longrightarrow [+\text{ gem.}] / \underset{[+\text{ stress}]}{\text{V}\ \_\_\_}$.

    However, we find geminate nasals and laterals in his fieldnotes. It has also been reported that "all consonants except semi-vowels and the flap can be geminated" (Chakravarti, 1976 : 7). The phonemic status of this phenomenon is unclear.

20. The occurrence of voiceless and voiced stops in Waḷuwara is in complementary distribution with vowel length (Breen, 1970 : 24). For example we find [pantu] "waist" and [pa:ndu] "butt of tree" (Dixon, pers. comm.). I have followed Breen's analysis and specified the distinctions as voiced/voiceless as opposed to vowel length.

It will be noted that the five methods of distinction: [voiced/voiceless], [aspirate/non-aspirate], [tense/lax], [fortis/lenis] and [geminate/non-geminate] are not mutually exclusive (c.f. f.n. 14 above); the choice of one or more as the "phonemic" contrast is due to the linguist involved. There is obviously a need for acoustic study of these languages in order to describe more accurately the nature of the distinction between the two series of stops (see also 3.1.2.3.1. and 3.4.2.2. below). The areal distribution of the second stop series is found on Map 7, Appendix 1.

1.1.4. PRENASALIZED STOPS

As well as the comments on prenasalization above (1.1.0.) I wish to make the further point that I am not making the claim that in Australian languages the syllable structure is such that any word initial consonant will be a unit phoneme. The use of the term prenasalized stops to describe initial clusters of a homorganic nasal and stop is a device to register similarity, thus recording the extent of initial clusters and prenasalized stops.

The occurrence of the word "initial" in brackets indicates the recording of initial clusters which have not been described as prenasalized stops.

Alyawarra (?)[21]	Andegeribina
Alawa	Burera (initial)
Aridingididh (initial)	Kalkatungu (initial)[22]

21. Alyawarra is included because prenasalized stops do occur phonetically; the analysis, however, is another problem. (Koch, pers. comm.).

22. Kalkatunga apparently only has initial /mb/, /nd/ and /ŋg/ (Blake, 1969 : 7).

Kaititj (?)[23]	Mbalidjan
Kuku-Thaypan	Ndra?angid (initial)
Mbabaram (initial)	Nggod (initial)
Mbara	Lama-lama
Mara	Yanyula (initial)
Mpakwithi	Yinwum
Mbeiwum (initial)	

It should be noted that Jagst sets up a series of prenasalized stops in Walpiri on the basis of the recording on initial /mp/ in one form (Jagst, 1975 : 21). However, on the basis of other data (Dixon, pers. comm.) and because the cluster was recorded in only one instance, we will not include a series of prenasalized stops in Walpiri.

Map 8 shows the areal diversity of prenasalized stops. We find that Cape York has a large percentage and these languages are known as being some of the Initial Dropping Languages[24] (Sutton, 1976 : 102-124). Eastern Arnhem Land and Central Australia are the other area where prenasalized stops are present.

1.1.5. NASALS

"The most powerful generalization opposed by not a single exception, is that the number of linear distinctions made among oral stops in a given language is identical with the number of linear distinctions made among nasals" (O'Grady, Voegelin C & F, 1966 : 57). This complements Ferguson's universal claim that no language has more nasal positions than stop positions (Ferguson, C., 1966 : 57).

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23. Kaititj has the same phenomenon as Alyawarra, c.f. f.n. 21 above.

24. These languages have the diachronic development of, for instance, /bambá/ > /mbá/ and thus we find synchronically, the initial homorganic nasal and stop cluster (c.f. Dixon, forthcoming a : 4).

Such a statement is fairly representative of the number of nasals in the majority of Australian languages. There are, however, a small group of languages which do not have a one-to-one correspondence of nasal and stop positions. The first type is found in Djingili and Ngarndji (C11 & 12 on map 9) where the palato-velar nasal /ŋj/ is not present (note, however, it was found in my acoustic analysis of Djingili (see 2.3.4.1.)). It is interesting to note that the other two languages with the equivalent stop arrangement, Garawa and Yanyula, have the corresponding nasal.

The second type of unequal correspondence involves the laminal nasal. In double laminal stop languages the dental nasal is either subphonemic or lacking. This is the case in the languages:

Djamindjung[25]	Wemba-wemba
Murinbata	Awngdim (?)
Ngangikurrungurr	Brinken
	Gugu-Badhun[26]

In the single laminal stop languages we find only two cases where the laminal nasal is lacking, Mabuiag and Lama-lama in Cape York. Map 9 shows that the languages where the number of nasals does not equal the number of stops are restricted to Cape York and the Northern Territory; Wemba-wemba on the Murray River is the only exception.

It is important to note that all languages have the same number of apical stops as apical nasals. Peripheral stops and nasals

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25. Djamindjung and the following three languages also lack the voiced dental stop whilst the voiceless /t̪/ is present (c.f. f.n. 16 above).

26. In Gugu-Badhun the distinction between the laminal stops is phonemic, in nasals it is phonetic. Note that /n̪/ $\rightarrow$ [n^y]/ —— i, [n̪] elsewhere. (Sutton, 1973 : 78). This is the same environment for the laminal stop alternation in Tiwi (see 1.1.1.1. above).

are also in a one-to-one correspondence excepting the palato-velar nasal as specified above. It is in the laminals that we find the cases where the number of stops does not equal the number of nasals.

1.1.6. LATERALS

Two points are worth noting in the discussion of the following position arrangements of laterals found in Australian languages. The first is directed at the type of analysis employed. Lateral position arrangements are discussed in terms of symmetry, where a one-to-one correspondence of laterals with non-peripheral stops is a symmetrical system. The non-symmetrical systems are listed according to stop arrangements. This gives us two sets of figures, discussed in 1.1.6.6. below.

The second point concerns the types of systems that do not occur. We do not find that the number of laterals is greater than the number of non-peripheral stops in any language. We also find that all languages with two laminal laterals also have two apical laterals. The single laminal lateral, single apical lateral type (1.1.6.2.) is small in number, suggesting that the laminal laterals are more phonologically complex. In nasals we saw that it was the laminal, or the laminal dental in double laminal stop arrangements, that was the subphonemic or lacking nasal. We may therefore suggest that laminals, especially the laminal dental place of articulation is the more complex.[27]

27. Complex is used in the sense of an implied hierarchy of phonological complexity, reflected by a greater number of positive values in a feature description. We find that only Chomsky and Halle's (3.1.1.2.) and Dixon's (3.1.1.4.) systems express this distributional aspect.

1.1.6.1. ℓ (51 = 38.06%)

Symmetrical: ø

Non-symmetrical:

Stop Type 1 (b d d^y g)

Gugu-Yalanji	Tiwi	Wargamay
Gidabal	Mulurudji	Warungu
Gureng-gureng	Mabuiag	Waalubal
Djaabugay	Maranunggu	Waka-waka
Dyirbal	Lenngidigh	Yidiny
	Lama-lama	

Stop Type 2 (b d $\underset{\cdot}{d}$ d^y g)

Djeebana

Stop Type 3 (b d $\underline{d}$ d^y g)

Awngdim	Kuuku-Thaypan	Ngiyamba
Aridingidigh	Thaayore	Ndra?angid
Umbila	Dhurga	Ludigh
Guugu-Yimidhirr	Dharawal	Wikmumin
Gugu-Badhun	Mbara	Wik-Ep
Koko-Bera	Mpakwithi	Wikmunkan
Kunjen	Mbalidjan	Yathaikana
Kurtjar	Mbeiwum	Yinwum
Gog-Nar	Mbabaram	Yuwaalaraay
Kuuku-Ya?u	Ngangikurrungurr	Nggod

Stop Type 4 (b d $\underset{\cdot}{d}$ $\underline{d}$ d^y g)

Bidyara	Lardil
Gungabula	Wemba-wemba

On the Map 10 we see the areal distribution of the single lateral languages restricted to Cape York and the east coast of Australia. The most inland languages are Wemba-wemba and Yuwaalaraay. In Arnhem Land we find the four languages Tiwi, Ngangikurrungurr, Maranunggu and Djeebana.

<u>1.1.6.2. ℓ ℓ^y (9 = 6.72%)</u>

This surprisingly is quite a rare system, occurring only in the following nine languages.

<u>Symmetrical</u>:

Stop Type 1 (b d d^y g)

Malag-malag	Nganjaywana	Ngarigu
Ngengomeri		Nyangumarda

<u>Non-symmetrical</u>:

Stop Type 2 (b d $\underset{.}{d}$ d^y g)

Yiwadja

Stop Type 3 (b d $\underline{d}$ d^y g)

Umbuygamu	Brinken	Yir-Yoront

There appears to be no areal congruence of this system. Map 11 shows us Nganjaywana in the east for instance and the Daly River languages in the north-west of Arnhem Land.

<u>1.1.6.3. ℓ $\underset{.}{\ell}$ ℓ^y</u> (30 = 22.39%)

<u>Symmetrical</u>:

Stop Type 2 (b d $\underset{.}{d}$ d^y g)

Alawa	Bard	Garadjari
Andagerinja	Pintupi	Gugada
Pitjantjatjara	Gudandji	Djaru

Madi-madi	Ngarinjin	Waramunga
Maung	Ngarla	Walmatjari
Mantjiltjara	NjungaR	Waḍaman
Mayali	Wambaya	Walpiri

Non-symmetrical:

Stop Type 4 (b d ḍ d̲ d^y g)

Kitja	Murinbata	Malyangapa
Djamindjung	Margany	Nunggubuyu

Stop Type 5 (b d ḍ (d̲) d^y gj g)

Garawa	Djingili	Ngaŕndji

Areally, we find that there are only two cases east of the eastern Northern Territory-South Australian north-south border (Map 12). They are Margany and Madi-madi; the rest of the languages in this lateral arrangement are scattered over the western three-quarters of the continent.

1.1.6.4. ℓ ḷ (26 = 19.14%)

Symmetrical: ∅

Non-symmetrical:

Stop Type 2 (b d ḍ d^y g)

Pungu-pungu	Gunwinggu	Rembarnga
Burera	Mara	Wadyiginy

Stop Type 4 (b d ḍ d̲ d^y g)

Gubabuyngu	Kurama	Datiway
Galpu	Djabu	Dalabon
Kukatj	Djambarrpuyngu	Mandelbingu
Kuthant	Thargari	Murawari[28]

28. Murawari may have the laminal palatal lateral, the status is uncertain (Oates, 1976 : 244).

Ngawun	Wangurri	Yinytyiparnti
Ritharngu	Warramiri	Yanhangu
Wagilak		Yukulta

On Map 13 we notice that there is a concentration of languages in eastern Arnhem Land, in the western area the Daly River languages Pungu-pungu and Wadyiginy. In Western Australia we find a few cases, but none are found in the central region of the continent. To the south of the Gulf of Carpentaria we find a few languages, the most inland being Ngawun. The most eastern case appears to be Murawari on the Queensland-New South Wales border.

1.1.6.5. ℓ $\underset{.}{\ell}$ $\underline{\ell}$ ℓ^y (18 = 13.43%)

Symmetrical:

Stop Type 4 (b d ḍ ḏ d^y g)

Andegeribina	Pita-pita	Nanta
Aranda	Kalkatungu	Waḷuwara
Alyawarra	Kaititj	Wanggumara
Arabana	Diyari	Wangganguru
Andiljaugwa	Ngaḷuma	Yaraldi
Bailko		Yandruwandha

Stop Type 5 (b d ḍ (ḏ) d^y gj g)

Yanyula

Non-symmetrical: ∅

Map 14 shows that the 4-lateral type is found predominantly in Central Australia. Yaraldi on the mouth of the Murray River is the southern most language. Yanyula and Andiljaugwa in Arnhem Land and a few cases in Western Australia are the only other cases outside this central region.

1.1.6.6. Stop and Lateral Distribution

TABLE 2: PERCENTAGES OF STOP AND LATERAL DISTRIBUTIONS

2.1. Lateral group by % of $\dfrac{\Sigma \text{ in each stop group}}{\text{Total } \Sigma \text{ of stops in each lateral group}}$

stop group

		1	2	3	4	5	Σ
	1	31.37	1.96	58.83	7.84	ϕ	100.00
lateral	2	55.56	11.11	33.33	ϕ	ϕ	100.00
group	3	ϕ	70.00	ϕ	20.00	10.00	100.00
	4	ϕ	23.08	ϕ	76.92	ϕ	100.00
	5	ϕ	ϕ	ϕ	94.44	5.56	100.00

2.2. Lateral group by % of $\dfrac{\Sigma \text{ of each stop type in lateral group}}{\text{Total } \Sigma \text{ of stops in each stop group}}$

Lateral group

		1	2	3	4	5	Σ
	1	76.19	23.81	ϕ	ϕ	ϕ	100.00
stop	2	3.45	3.45	72.41	20.69	ϕ	100.00
group	3	90.91	9.09	ϕ	ϕ	ϕ	100.00
	4	8.51	ϕ	12.77	42.55	36.17	100.00
	5	ϕ	ϕ	75.00	ϕ	25.00	100.00

Table 2 (p. 22) shows the percentages of membership to each combination. The zero (ø) components are predictable in most cases for there cannot be a lateral which has no corresponding stop phoneme. Therefore type 1 stop system cannot occur with types 3-5 lateral systems. A type 3 stop system is a single apical and is thus excluded from lateral system types 3-5. Type 5 stop system includes only four languages so we would expect gaps in its lateral series membership. However, we find the null set for type 4 stop system and type 2 lateral system. In other words, we find no instances of the stop and lateral combination of:

$$\begin{array}{cccccc} b & d & \underset{\cdot}{d} & \underline{d} & d^y & g \\ & \ell & & & \ell^y & \end{array}$$

It is worth noting the following more common combinations from both tables:

stop type 3 and lateral type 1
$$\begin{array}{ccccc} b & d & \underline{d} & d^y & g \\ & \ell & & & \end{array}$$

stop type 4 and lateral type 4
$$\begin{array}{cccccc} b & d & \underset{\cdot}{d} & \underline{d} & d^y & g \\ & \ell & \underset{\cdot}{\ell} & & & \end{array}$$

stop type 1 and lateral type 2
$$\begin{array}{cccc} b & d & d^y & g \\ & \ell & \ell^y & \end{array}$$

stop type 2 and lateral type 3
$$\begin{array}{ccccc} b & d & \underset{\cdot}{d} & d^y & g \\ & \ell & \underset{\cdot}{\ell} & \ell^y & \end{array}$$

On the other hand, unlikely combinations are as equally relevant, for example:

stop type 2 and lateral type 1
$$\begin{array}{ccccc} b & d & \underset{\cdot}{d} & d^y & g \\ & \ell & & & \end{array}$$

stop type 4 and lateral type 1
$$\begin{array}{cccccc} b & d & \underset{\cdot}{d} & \underline{d} & d^y & g \\ & \ell & & & & \end{array}$$

stop type 4 and lateral type 3
$$\begin{array}{cccccc} b & d & \underset{\cdot}{d} & \underline{d} & d^y & g \\ & \ell & \underset{\cdot}{\ell} & & \ell^y & \end{array}$$

1.1.7. PRESTOPPING

This section concerns prestopped nasals and laterals. It is felt that in terms of distribution, it is better to regard this phenomenon as prestopping rather than "stops with nasal release" (O'Grady, Voegelin, C & F, 1966 : 59) and laterally released stops. Phonotactically, prestopped nasals for instance have the same distribution as nasals in Kaititj (Koch, pers. comm.), and sometimes alternate with long nasals in both Kaititj and Alyawarra (Yallop, 1977 : 12).

Prestopped nasals occur in the following languages:

Aranda	Arabana	Kaititj
Alyawarra	Kunjen	Wangganguru

Arabana and Wangganguru lack the retroflex and velar prestopped nasal, the other languages have six except Kunjen with five, the retroflex is absent.

Prestopped laterals are found in Yandruwandha, Arabana and Wangganguru. Again, Arabana and Wangganguru do not have a full set of four; the retroflex is lacking.

It should be noted that the number of prestopped nasals does not exceed the number of nasals and likewise for the laterals. Excepting Kunjen, all the languages have six nasals and four laterals. Yandruwandha is the only language that has prestopped laterals but no prestopped nasals.

Map 15 shows that Kunjen in western Cape York is the only language distant from the rest in the central region of Australia; otherwise this phenomenon is an areal feature.

1.1.8. PREPALATALIZATION

In Andegeribina we find the only case of phonemic prepalatalization in the data surveyed. This is a device employed to allow for a morphophonemic two vowel system of a/a: (Breen, 1977 : 384) (see also 1.2.3. below). Andegeribina is found in Central Australia, C6 on Map 15.

1.1.9. RHOTIC RELEASE

The rhotic release of apical stops and the alveolar prestopped nasal appears to be a different phenomenon from the prestopping of certain stops before rhotics (see also 3.1.2.3.5. below). In Mpakwithi for instance, rhotic released stops function phonotactically as stops and not as rhotics (Crowley, pers. comm.).

/d^{r}/ is found in:

Awngdim	Ndra?angid	Yinwum
Aridingidigh	Nggod	Yandruwandha
Mpakwithi	Lenngidigh	

/nd^{r}/ is found in:

Mpakwithi	Ndra?angid	Yinwum

/ḍ^{r}/ is found in:

Yandruwandha

Breen regards the rhotic released stops in Yandruwandha as prestopped trills (Breen, 1976b : 597), presumably on the basis of phonological similarity with prestopped laterals. However, there is no evidence as to the phonotactic function of the rhotic release stops in Yandruwandha, whether they function in the same manner as stops or rhotics.

It is felt however, that they are best described as rhotic released stops as opposed to prestopped trills for we notice that /d^{r}/ occurs elsewhere and functions phonotactically as a stop. It is also somewhat discordant to describe /ḍ^{r}/ as a retroflex prestopped trill as opposed to a rhotic released retroflex stop.

Areal occurrence of the rhotic released stop is in Cape York, with Yandruwandha in Central Australia the only exception, (see Map 16).

1.1.10. LABIALIZATION

Labialization is a phonotactic or prosodic device employed to describe the rounding of certain consonants in a manner similar to the phonological constructions of the preceding three sections. The languages and their respective labialized consonants are:

Andiljaugwa : g^w $ŋ^w$

Mbabaram (?) : g^w ($ŋ^w$) d^w n^w

Andegeribina : mb^w $ŋg^w$ b^w g^w m^w $ŋ^w$ M^w $Ŋ^w$

Tiwi : unknown (Breen, 1977)

Alyawarra : b^w d^w $ḍ^w$ g^w $ŋ^w$ $ḷ^w$ (?)

It is important to note that Alyawarra and the other Arandic languages in this study (Aranda and Kaititj) do have phonetic rounding on some consonants, their status being a matter of morphophonemic arrangement (Koch, pers. comm.). The Alywarra data above is taken as being phonemic by its researcher (Turtle, 1977 : 6).[29]

We notice that mainly peripherals and apicals can be labialized. Only one laminal, the palatal prenasalized stop in Alywarra (c.f. f.n. 29) was recorded. The manners of articulation where rounding occurs are stops, nasals, prenasalized stops and prestopped nasals. Only one lateral, the retroflex in Alyawarra was recorded.

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29. Yallop recorded in Alyawarra the following consonants as being the first members of a cluster where the second is /w/: b, d, g, M, Ŋ, m, ŋ, n, mb, nd, n^yd^y. (Yallop, 1977 : 43).

Geographically, Map 17 shows the Central Australian languages, Mbabaram in Cape York, Andiljaugwa on Groote Island and Tiwi on Melville and Bathurst Islands.

1.1.11. RHOTICS

In Australian languages four rhotics have been recorded; the flap, trill and two glided rhotics, the retroflex and alveolar. The majority of languages, 80.60%, have two rhotics, the retroflex continuant /R/[30] and the flap or trill /r/.[31] In the remaining four types of arrangement we notice that we do not find the flap and trill without the retroflex continuant but do find just a flap or trill without the continuant. We also find only one doubtful case of the continuant rhotic /R/ as the only rhotic present in the phonology of a language. One language contrasts the two continuant rhotics, with the trill or flap.

1.1.11.1. R r (continuant, trill/flap) (108 = 80.60%)

Aridingidigh	Andegeribina	Bidyara
Awngdim	Arabana	Bailko
Andagerinja	Umbila	Bard
Alawa	Umbuygamu	Pitjantjatjara
Andiljaugwa	Burera	Brinken
Alyawarra	Pungu-pungu	Kaititj
Aranda	Pintupi	Galpu

---

30. I prefer to use /R/ and not /ɽ/ (c.f. Dixon, 1972) for orthographic ease; it does not suggest a uvula trill as its IPA value might imply. IPA /ɹ/ is conventionally not used in describing Australian languages and is reserved here for the alveolar glided rhotic in Murinbata (1.1.11.5. below).

31. /r/ in this case usually has both flap and trill allophones. In those languages where the trill and flap are in phonemic contrast, the flap is marked as /r/ and the trill as /ř/.

Garadjari	Mbabaram	Nunggubuyu
Kurama	Mandelbingu	Lenngidign
Gudandji	Maranunggu	Lardil
Kalkatungu	Mbara	Rembarnga
Kunjen	Mbeiwum	Ritharngu
Gungabula	Mantjiltjara	Wadyiginy
Gugu-Badhun	Mayali	Wangganguru
Gubabuyngu	Mara	Warramiri
Guugu-Yimidhirr	Maung	Wangurri
Garawa	Mpakwithi	Wagilak
Kuku-Thaypan	Mulurudji	Wikmunkan
Gugada	Murawari[32]	Waka-waka
Koko-Bera	Malag-malag	Wik-Ep
Gunwinggu	Margany	Waḍaman
Gugu-Yalanji	Ngarndji	Warungu
Kitja	Ngarla	Waḷuwara
Djamindjung	Nganjaywana	Wemba-wemba
Djeebana	Ngengomeri	Wargamay
Dyirbal	Nggod	Walmatjari
Djabu	Ngiyamba	Waramunga
Djaabugay	Ngarinjin	Wambaya
Djambarrpuynggu	Ngawun	Wikmumin
Djingili	Ngangikurrungurr	Yathaikana
Djaru	NyungaR	Yanhangu
Thaayore	Nyangumarda	Yir-Yoront
Tiwi	Ndra?angid	Yukulta
Datiway	Nanta	Yaraldi

32. Murawari may have three rhotics /R, r, r̆/ (Oates, 1976 : 244).

Yinwum	Yanyula	Yinytyiparnti
Yiwadja[33]	Yidiny	Yuwaalaraay

1.1.11.2. r (trill/flap) (11 = 8.21%)

Gureng-gureng	Dhurga	Ngarigu
Gidabal	Madi-madi	Ludigh
Kuuku-Yaʔu	Mabuiag	Waalubal
Dharawal	Mbalidjan	

Map 18 shows that the areal distribution of this system is restricted to the east coast of Australia. The most western language appears to be Madi-madi.

1.1.11.3. R r ř (continuant, flap, trill) (13 = 9.70%)

Pita-pita	Dalabon	Lama-lama
Gog-Nar	Diyari	Walpiri
Kurtjar	Malyangapa	Wanggumara
Kuthant	Ngaḷuma	Yandruwandha
Kukatj		

A fairly widespread areal distribution is found (Map 19) with Lama-lama in Cape York the most eastern language. Otherwise, predominance in the Gulf region and northern South Australia account for most; Ngaḷuma is the most western language in this survey.

1.1.11.4. R (continuant) (1 = 0.75%)

The single glided rhotic is found in one language. Thargari in Western Australia (see Map 20). It has been recorded that [r] is

33. Yiwadja may have three rhotics /R, r, ř/ (O'Grady, Voegelin, C & F., 1966 : 62 and Capell, 1962 : 129).

an allophone of /t/, for Klokeid lists /r/ with the stops in his phonemic arrangements and states: "/r/ has voiced flap and trill allophones which are in free variation in most environments with the voiceless stop allophones, and are in fact more frequently occurring" (Klokeid, 1969 : 3). Austin (pers. comm.) has suggested that there may be two phonemes /t/ and /r/, but he is still unsure of their true status.

Due to this being the only example of a language with a retroflex glided rhotic and since researchers appear to disagree, the status and validity of this rhotic system is in doubt.

1.1.11.5. r R ɹ (trill/flap, retroflex and alveolar continuants) (1 = 0.75%)

On Map 20 we note that the only language with this system, Murinbata, is located in the Port Keats region of the Northern Territory. We may be tempted to dismiss this system on the grounds that it occurs in only one language but it should be noted that its occurrence is well documented (Walsh, 1976) and is acoustically provable (see 2.4.2.). In fact, even the language name contains the alveolar glided rhotic, "muɹinypata" (Walsh, 1976). The neighbouring languages, Djamindjung and Ngangikurrungurr, which share many common features (c.f. f.n. 16 above) do not have these three rhotics. They have the more frequent system of two rhotics, /R/ and /r/.

1.1.12. GLIDES

Nearly all languages have two glides /w/ and /y/ (129 = 96.27%), with some languages having three.

1.1.12.1. y y̪ w (2 = 1.49%)

The extra glide is an interdental, occurring in only two languages in Western Australia, Kurama and Yinytyiparnti (Map 21) of which not much detail is available.[34] This glide is apparently produced with the sides of the tongue against the cheek, the tongue is held flat and the tip is under the bottom teeth (Wordick, pers. comm.).

1.1.12.2. w ẅ y (3=2.24%)

Unrounded /w/, transcribed as /ẅ/ (IPA [ɰ̆]) occurs in Kaititj, Wik-Ep and Waḷuwara (see Map 21). In Kaititj it has developed from the velar fricative, and in some instances is produced with some friction or allophonically alternates with the velar fricative (Koch, pers. comm.).

1.1.13. FRICATIVES

Fricatives are found in Arnhem Land, Cape York and Central Australia. Map 22 shows the areal distribution and we note that Thargari in Western Australia is the only language outside this area.

I have attempted to standardize symbols employed by various authors. There is no need, for instance, to distinguish voiced and voiceless fricatives in any language except Mabuiag. To use symbols denoting such a difference may be phonetically accurate but phonemically irrelevant. The voiced symbols will be used in the same manner as was employed in the stop analysis (c.f. 1.1.0.). We find the following types.

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34. It has been suggested that the diachronic development of /y̪/ has been l̪ > t̪
t̪ > y̪ (Workick, pers. comm.)

<u>1.1.13.1. γ</u> (6 = 21.43% of languages with fricatives

= 4.48% of total number of languages)

Aranda	Kuthant	Maung (?)
Alyawarra	Tiwi	Yiwadja (?)

<u>1.1.13.2. γ ð β</u> (14 = 50.00% of languages with fricatives

= 10.45% of total number of languages)

Aridingidigh	Kuuku-Thaypan	Ludigh
Awngdim	Mbeiwum	Lenngidigh
Umbuygamu	Mbalidjan	Yinwum
Kunjen	Nggod	Yathaikana
Kurtjar	Ndra?angid	

<u>1.1.13.3. γ β</u> (1 = 3.57% of languages with fricatives

= 0.75% of total number languages)

Gog-Nar

<u>1.1.13.4. ð</u> (2 = 7.14% of languages with fricatives

= 1.49% of total number of languages)

Thargari

Mbara (?)

<u>1.1.13.5. z β</u> (1 = 3.57% of languages with fricatives

= 0.75% of total number of languages)

Ngengomeri (?)

<u>1.1.13.6. s z</u> (1 = 3.57% of languages with fricatives

= 0.75% of total number of languages)

Mabuiag

<u>1.1.13.7. γ z β</u> (1 = 3.57% of languages with fricatives

= 0.75% of total number of languages)

Lama-lama

<u>1.1.13.8. z ʒ β</u> (1 = 3.75% of languages with fricatives

= 0.75% of total number of languages)

Ngangikurrungurr

<u>1.1.13.9. γ ʒ ð β</u> (1 = 3.75% of languages with fricatives

= 0.75% of total number of languages)

Mpakwithi, which has the largest number of fricatives in any one language surveyed.

In general, fricatives are uncommon sounds at the phonemic level, found in only twenty-eight languages (20.90%) in this study. The absence or relative scarcity of fricatives is a major Australian areal characteristic.

<u>1.2.0. VOWEL PHONEMES</u>

The vowel phonemes of Aboriginal languages, found on Table 3 (p. 34), have the same characteristics of distribution that we found in the consonants. Both vowels and consonants in the majority of languages fit into a small set of distributional combinations, with just a small number of aberrant languages. For example, the vowel system /i a u/ is found in 53.73% of all languages.[35]

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35. The percentage figure is of all languages with this vowel system, irrespective of the presence or absence of a length distinction.

TABLE 3: VOWEL PHONEMES

	Front		Central		Back
	-rnd	+rnd	-rnd	+rnd	+rnd
close	i	ü	ɨ	ʉ	u
half-close	e	ö	ə		o
half-open	æ				ɔ
open			a		

Diphthongs: ua, ɨa(:), ui, ai, ia(:)

Nasalized vowels: ĩ, ẽ, æ̃, ã

Length is distinct for the following vowels.

The bracketed forms are of uncertain status

i (ü) (ɨ) (ʉ) u

e (ö) (ə) o

æ a

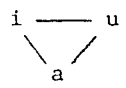
We can divide the vowel arrangements into three major types in order to examine their distributions.

1.2.1. Symmetrical systems, where there is symmetry both in the structure of the vowel diagram and in the presence and absence of a length distinction.

1.2.2. Semi-symmetrical systems, where there is some form of symmetry or similarity present.

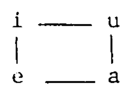
1.2.3. Ungrouped systems; this being a collection of languages which do not fit into the above two types. It should be noted that vowel systems falling into this group are the more aberrant forms, where one system is unique to one language. The exception is the system /i u a a:/ which has three members.

1.2.1. Symmetrical systems



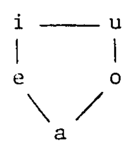
1.2.1.1.1. i a u

1.2.1.1.2. i a u [± length]



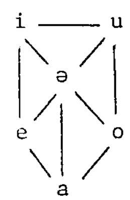
1.2.1.2.1. i e a u

1.2.1.2.2. i e a u [± length]



1.2.1.3.1. i e a o u

1.2.1.3.2. i e a o u [± length]



1.2.1.4.1. i e a o u ə

1.2.1.4.2. i e a o u ə [± length]

1.2.1.1. i a u

Map 23 shows the distribution of the vowel system /i a u/ without regard for the length distinction. There appears to be no areal congruency.

1.2.1.1.1. i a u (23 = 17.16%)

Pita-pita	Dyirbal	Waḷuwara[36]
Bidyara	Tiwi	Wambaya
Garawa	Diyari	Warungu
Gugu-Badhun	Mara	Wanggumara
Kunjen	Ngawun	Yanyula
Gungabula	Nganjaywana	Yaraldi
Gugu-Yalanji	Ngarla	Yandruwandha
Garadjari	Wikmumin	

1.2.1.1.2. i a u [± length] (49 = 36.57%)

Alyawarra	Kalkatungu	Datiway
Aranda	Gugada	Murawari
Arabana	Galpu	Mulurudji[39]
Andagerinja	Kukatj[38]	Mantjiltjara
Umbila	Djeebana	Malyangapa
Pitjantjatjara	Djabu	Margany
Bailko[37]	Djingili	Mandelbingu
Pintupi	Djambarrpuynggu	Ngiyamba
Guugu-Yimidhirr	Djaabugay	Ngaḷuma
Kuuku-Ya?u	Thargari	Ngarigu
Gubabuyngu	Dharawal	Nyangumarda
Kurama	Dhurga	Nanta

---

36. Refer to f.n. 20 as to why the length distinction in Waḷuwara is not recorded here.

37. Bailko may not have a length distinction (O'Grady, Voegelin C & F, 1966 : 85).

38. Kukatj may have schwa (Breen, 1976c : 154).

39. Mulurudji may not have a length distinction (O'Grady, Voegelin C & F, 1966 : 67).

Ritharngu[40]	Wangurri	Yukulta
Waramunga[41]	Warramiri	Yanhangu
Walmatjari	Wangganguru	Yidiny[43]
Wargamay[42]	Walpiri	Yuwaalaraay
Wagilak		

1.2.1.2. i e a u

Map 24 shows the areal distribution of this system. It appears that there are no cases in Central and Western Australia. We find languages in Cape York and the east coast, Madi-madi in the south and a few cases in western Arnhem Land.

1.2.1.2.1. i e a u (8 = 5.97%)

Alawa	Madi-madi	Ndra?angid
Djamindjung[44]	Ngangikurrungurr	Yinwum
Murinbata	Ngengomeri	

1.2.1.2.2. i e a u [± length] (5 = 3.73%)

Gidabal	Lardil	Waalubal[45]
Gureng-gureng		Yathaikana

---

40. Rithangu has length on the first syllable of a word only (Heath, 1978 : 34).

41. Waramunga may not have a length distinction (Chakravarti, 1967 : 6; Hale, 1959; Capell, 1953 : 298).

42. Wargamay has length on the first syllable only (Dixon, forthcoming b : 22).

43. Yidiny has a length distinction only in non-initial syllables (Dixon, 1977 : 2-3)..

44. The status of /e/ is uncertain in Djamindjung (Walsh, pers. comm.).

45. Crowley remarks that the length of the vowel /e/ is predictable by rule (Crowley, 1978 : 6-21). However, for symmetry and for areal congruence, an /e:/ is included as part of the phoneme inventory.

1.2.1.3. i e a o u

Map 25 shows the sporadic occurrences of this vowel arrangement. One example in the south-west, NjungaR, but none are found south of the New South Wales-Queensland border.

1.2.1.3.1. i e a o u (7 = 5.22%)

Burera[46]	Mayali	Waḍaman
Gunwinggu	Ngarinjin	Yiwadja
	NjungaR	

1.2.1.3.2. i e a o u [± length] (5 = 3.73%)

Thaayore	Maung	Waka-waka
Mbara		Wikmunkan

1.2.1.4. i e a o u ə

The six vowel system has a restricted areal distribution (Map 26). Cases are found in Cape York and Arnhem Land, with Wemba-wemba being the only language outside this area.

1.2.1.4.1. i e a o u ə (5 = 3.73%)

Koko-Bera	Rembarnga	Wemba-wemba[47]
Lama-lama		Yir-Yoront

1.2.1.4.2. i e a o u ə [± length] (2 = 1.49%)

Dalabon

Mabuiag[48]

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46. Burera is reported as having word stress like English 'import/imp'ort (Glasgow D & K, 1962 : 2 and Glasgow, 1966 : n.p.). This is the only language where stress is reported at the phonemic level.

47. Vowel length in Wemba-wemba is predictable by rule (Hercus, 1969 : 28).

48. Mabuiag has no length on schwa (Klokeid, 1971 : 19).

1.2.2. Semi-Symmetrical Systems

Map 27 shows the position of the /i a o u/ vowel system, both languages are in Western Australia. The distribution of /i e a u ə/ can be found on Map 28, an area restricted to the Daly River region and only one case in Cape York, Awngdim.

It is of interest to note that there are more cases of /i e a u/ than of /i a o u/; disregarding length and schwa. Nineteen cases are found of the former and only two of the latter.

The following is a list of vowel systems and their language members.

i a u [± length] o (1 = 0.75%)

Bard

i a u [± length] o: (1 = 0.75%)

Yinytyiparnti

i e a u ə (6 = 4.48%)

Awngdim	Pungu-pungu	Maranunggu
Brinken[49]	Malag-malag	Wadyiginy

i e a u ɨ (1 = 0.75%)

Andiljaugwa[50]

i e a o u ə ö (1 = 0.75%)

Gog-Nar

i æ a u[51] (2 = 1.49%)

Ludigh

Mbalidjan

---

49. Brinken may not have schwa (Tryon, 1974 : 71).

50. Dixon (pers. comm.) suggests that Andiljaugwa has the vowel /ɨ/

51. It appears that /æ/ is not a notational variant of /e/ for the former is apparently common in Northern Paman languages (Hale, 1976 : 7-40).

i æ a o u (1 = 0.75%)

Lenngidigh

1.2.3. Ungrouped Systems

i u a a: (3 = 2.27%)

Ngarndji Nunggubuyu Djaru

i ɨ u a a: (1 = 0.75%)

Kitja

i e a o u ɨ ʉ [± length] (?) (1 = 0.75%)

Mbabaram[52]

i e æ a ɔ o u ɨ (?) (1 = 0.75%)

Kuku-Thaypan

i u ʉ æ a (1 = 0.75%)

Aridingidigh

i ü u e o a (1 = 0.75%)

Mbeiwum

i u e ö o æ a (1 = 0.75%)

Nggod

i e a o u ü ö (ɨ) (ʉ) [± length] (?) (1 = 0.75%)

Wik-Ep

i ö u a ɨa ia [± length] ɨ (1 = 0.75%)

Kuthant[53]

e ö o a ɨa [± length]

Kurtjar

52. Mbabaram, like Kuku-Thaypan in the next arrangement is symmetrical on the vowel diagram.

53. Note that diphthongs may be notational variants of Vowel + Glide or Glide + Vowel. However the notation used by the author has been followed here.

i a u ua (1 = 0.75%)

Umbuygamu

i a u ui ai (1 = 0.75%)

Gudandji

2 vowel systems (2 = 1.49%)

Andegeribina[54] a a:

Kaititj ə a

Finally, the largest vowel system, Mpakwithi

i(:)	ĩ	ü	u(:)
e(:)	ẽ	(ö)	o
æ(:)	æ̃		
a(:)	ã		

1.2.4. RESIDUE AREAL DISTRIBUTION

1.2.4.1. Vowel Systems

Map 29 provides us with the occurrences of all languages that have not yet been geographically positioned, excepting the two vowel systems in Kaititj and Andegeribina. They include all of 1.2.3. and 1.2.2. except /i e a u ə/ and /i a o u/, the former being found on Map 28, the latter on 27. It is of interest to note that these languages are restricted to the northern quarter of the continent, with Cape York having the greater density.

Map 30 indicates the occurrence of diphthongs in Umbuygamu (Y19), Kuthant (G8), Kurtjar (G9) and Gudandji (C14). Nasalized vowels in Mpakwithi (Y32) and the two-vowel systems (C6 and C8) are also marked on this map.

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54. Note that Andegeribina also has prepalatals and rounded consonants (c.f. 1.1.8. and 1.1.10. above).

1.2.4.2. Length Distinctions

The distinctions between long and short vowels is evenly distributed across the whole continent, easily verified by an examination of Maps 31 and 32. Length is found to be distinctive in 73 cases which is 54.48% of the total number of 134 languages in this study.

1.3.0. CONCLUSION

We notice certain regularities in the distribution of phonemes in phonological systems in Australian aboriginal languages. For instance, every system studied has at least four positions of articulation for stops and nasals, where there is usually a one-to-one correspondence of positions of articulation between these two manners of production. Every language has at least one lateral, one rhotic although the norm is two, and usually two glides. Vowel systems are dominated by /i a u/, but other systems are not so uncommon.

It is of importance to note that these phonological occurrences in the majority of aboriginal languages provide the basis of Dixon's feature system and the major distinction between primary and secondary manners of production (see 3.1.1.4. and 3.1.2.).

In the analysis of areal distributions we notice that the eastern Northern Territory-South Australian north-south border plays an important role in the distributions of the stop system /b d ḍ d^y g/ (1.1.1.2.) and the lateral system /ℓ ℓ̣ $ℓ^y$/ (1.1.6.3.). The Cape York region and the east coast of the continent are predominant in the distributions of stop systems 1.1.1.1. (/b d d^y g/), 1.1.1.3. (/b d d̲ d^y g/), the single lateral /ℓ/ (1.1.6.1.), and the occurrence of the single rhotic /r/ (1.1.11.2.).

Cape York and Arnhem Land are significant areas in a number of distributions. The former has a large concentration of rhotic release stops (1.1.9.), fricatives (1.1.13.) and ungrouped vowels (Map 29). The latter is important in the distribution of the second stop series (1.1.3.), the lateral type /ℓ ḷ/ (1.1.6.4.); whilst both have a high incidence of the glottal stop (1.1.2.).

2.0 ACOUSTIC ANALYSIS

In the previous section we saw the types of phonemes that occur in aboriginal languages and how they are distributed in phonological systems. The analysis that follows is an examination of the acoustic structure of phonological segments, the phonetic realizations of the phonemes that make up the systems of a language.

However, in the analysis of segments we must distinguish between an acoustic description and an acoustic definition. A description will entail a detailed physical analysis of all aspects of the speech situation; a definition can be seen as a statement of the distinctiveness of one segment from another. This latter aspect is reflected in distinctive feature theory (c.f. Section 3), where the definition of a feature is relative and dependant upon its distinctiveness from another phoneme. This is most relevant to our analysis for we are interested in the manner by which these segments are distinguished. "There is no absolute point for which we can say that the concentration of energy in a frequency spectrum above this point signifies acuteness, while concentration below signifies gravity" (Chomsky, 1972 : 344). This relative nature of distinctiveness concerns us and not the acoustic description in terms of the physical dimensions of a sound; the latter can be seen as more appropiate for the description of a speech segment (c.f. Fant's feature system, 3.3.0. below) than of a phoneme.

It is implied in the structure of phonological systems that the same relative differences between positions of articulation apply to differing manners of production. This is the case for nasals, laterals and stops in feature inventories (c.f. 3.1.1. below). Such an assumption may not necessarily apply; the reason lies in the relative nature of phonological distinctions as opposed to an acoustic description of physical properties. Therefore, the descriptions of the distinguishing parameters that follow will not necessarily be the same for all manners of articulation. However, correlations and similarities are found and thus we can examine the relational patterns that these imply.

Therefore, the distinguishing parameters specified are some of the acoustic differences between sets of sounds and not a total acoustic description of a segment. Also, they are not the acoustic structure of phonemes, nor their feature specifications which are a relational construct based upon the differences within a system.

2.1.0. LANGUAGE SELECTION

The selection of languages for acoustic analysis is based on four considerations. We find in the first instance, that the Spectrograph[55] has physical limitations in its ability to filter the harmonics of female voices into readily measurable formants. It is therefore necessary to exclude those languages of good quality taped material where the informant is female. It will be noted that two languages are included which have female informants; Yukulta because the F_o (fundamental frequency) of the female speaker is low and similar to that found in usual male speech. (An example can be found in Appendix 8 (1)). Djabu is the other language for its data is a video print and useful for the visual observation of the positions of articulation.

Secondly, there is the necessity for good quality recordings,

55. Sound Spectrograph, Series 700: Voice Identification, Inc. This is a similar machine to the Kay in that they both use a 300 cps wideband filter.

where background noise is at a minimum[56] and the speech is clear and concise but not too rapid. Word elicitation is thus more suitable than text; the former is usually more precise in pronunciation than the latter which is also more difficult to follow, both by ear and in transcriptions.

The third consideration rests with the non-arbitrary choice of languages. Due to the limitations of the dimensions of this study, it was necessary to be selective as to which languages were to be studied. I felt that typical Australian languages, like Pitjantjatjara, should be included as well as the more aberrant types such as Mpakwithi.

Finally, not all tapes and fieldnotes are readily available. The Australian Institute of Aboriginal Studies[57] has access and use restrictions and thus those languages with minimal restrictions were used in preference to others.

With all four factors to be considered, from a total of 68 languages for which tapes were considered and listened to, the following nineteen were selected; others were rejected for one or more of the above reasons.

Arabana (Hale, 1959)	Kurtjar (Keen, 1968)
Pitjantjatjara (Univ. of Adelaide, 1969)	Kuuku-Ya?u (Rigsby, 1972)
	Djambarrpuynggu (Henley, 1978)
Kaititj (Koch, 1974-)	Djabu (Henley, 1978)

56. Low or very high frequency interference can be filtered so that its effect is not as great. In Kaititj, for instance, a generator noise in the background was filtered using a high-pass filter at 220 cps. Filtering was performed on an Audio-Frequency Filter, Type 440: F-J Electronics A/S, with the steep (36 db/octave) filter slope.

57. The Institute's tape archive and library was the source of all tapes excepting those for Yathaikana, Djabu, Djambarrpuynggu, Mpakwithi and Kaititj which were provided by their respective researchers.

Djingili (Hale, 1960)	Wikmunkan (Hale, 1959)
Diyari (Austin, 1977)	Waramunga (Hale, 1959)
Murinbata (Walsh, 1972-)	Yathaikana (Crowley, 1975)
Mpakwithi (Crowley, 1975)	Yukulta (Keen, 1970)
Mara (Hale, 1959)	Yanyula (Hale, 1959)
Wik-Ep (Hale, 1960)	Yandruwandha (Breen, 1967-)

The phonological systems of these languages can be found in Appendix 2. Approximately 860 items were spectrographically recorded of which about one quarter were sections. This gives approximately 48 items per language.

2.2.0. METHODOLOGICAL PRELIMINARIES

There are two methodological aspects that need to be considered before the analysis is presented. The first is concerned with the method of acoustic data selection on which the data are based, the second is the process of standardization of the raw data by various statistical methods in order to make the results more comparable.

2.2.1. ACOUSTIC DATA SELECTION

It was noted in the introduction to this section that in the acoustic analysis that follows we are concerned with the acoustic differences between sets of sounds. These sounds, or phones, are analysed across languages for we assume that the gross physical properties of one sound in one language is the same as a similarly described sound in another. We must note that this analysis is not the comparison of one phoneme with another, for a phoneme's distinctiveness rests in its opposition to other phonemes within a system (Trubetzkoy, 1969 : 67). Rather, it is a comparison of some acoustic properties of one class of phones with another.

"It seems to me, then, that there is enough acoustic sameness in the vast majority of implementations of one phoneme,[58] and sufficient reluctance, for practical reasons, to convert the elasticity of phoneme boundaries into phonetic arbitrariness and licence, so that circumscription and acoustic definition of phonemes on an absolute scale, albeit one with elastic boundaries, are both feasible and necessary" (Pulgram, 1964 : 149). For it must be recalled that "the concept of speech as a sequence of discrete units with distinct boundaries joined together as beads on a string is contrasted to the view of speech as a continuant succession of gradually varying and overlapping patterns" (Fant, 1973 : 21). The use of statistical manipulation of the raw data is an attempt to minimize the effects of phonetic boundaries (see 2.2.2. below).

We can distinguish between two methods of acoustic data analysis. The first is the use of spectrographic sections, taken at points as close as practicable to the centre of a sound. This is suitable for those sounds which have an intrinsic formant structure, the sonorant phonemes.[59] Non-sonorant phones, such as stops, are analysed by the second method, this being the measurement and projection of formant transitions in adjacent sonorant segments. Note that the

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58. Even though Pulgram refers to phonemes, his comments are directed not at phonological oppositions but at the acoustic structure of what we have labelled phones. In this respect, his comments are applicable to our analysis.

59. Sonorant phonemes are those "with an auditory property which arises from their having a comparatively large amount of acoustic energy within a clearly defined formant structure" (Ladefoged, 1971 : 58). In Australian languages these are the nasals, laterals, rhotics, glides and vowels. However, sections were only taken for nasals and laterals, the other sonorants have such a clear formant structure that sections proved unnecessary.

consonantal sonorants also show formant transitions in adjacent segments and transitions were measured for both nasals and laterals. For our purposes we find it practical to regard the transitions of the vowel formant as one of our acoustic parameters and thus we examine the direction and relative frequencies of these transitions.

2.2.2. THE STANDARDIZATION PROCESS

In order to simplify our data and make the results more comparable we must attempt to minimize the effects of the following problems inherent in our data. Errors of analysis, on my part and in the transcription of the researcher, idiosyncratic speech habits of the informant and various environmental factors are all indicative of the types of problems that will naturally exist. We can assume, however, that the distribution of these factors will be at random and to minimize their effect we can statistically standardize our data so that one set of data can be compared with another with some confidence that the results are affected minimally. For standardization of our data will allow for a more valid comparison of two segments than will simple raw data comparison.

Standardized data will also provide us with information as to the nature and extent of the distribution of our real data. We have two simple statistical methods of achieving this effect. (See Appendix 3 for formulae and notations). The mean, or average, is the "Central reference value" (Ferguson, G., 1966 : 45), suitable for cursory comparisons. It does not, however, tell us anything about the distribution of the data around the mean, this is calculated by the standard deviation. We can draw upon these two calculations to make a third, ore important calculation, the 95% confidence limits. These limits are a "statement that we are 95 per cent confident that the actual population mean falls within certain specific limits" (Ferguson, G., 1966 : 153).

The statistical methods of analysis provide us with the means by which we can confidently compare the data. It will be noted that the data presented in the Appendices also contain the number of samples (n) and the standard error (S.E.). These are necessary for the calculation of the 95% confidence limits, their formulae can be found in Appendix 3, and are included for the statistically orientated.

2.3.0. ARTICULATORY PLACE ANALYSIS

The order of analysis in the previous section followed the specification given in Table 1, that of stops, nasals and laterals. In this section I will reverse the order; for the analysis is clearest for laterals, which have both clear formants and clear transitions, less so for nasals, with stop transitions being the least clear.

Spurious formants in the 800-1200 cps range hindered our analysis. McDonald found that F_1 in some of her examples was indeterminable because of an "abundance of bound poles in the lower frequencies. This pattern recurs with both laminals - enough to be a characteristic, if minor, of the laminal pattern" (McDonald, 1977 : 45). However, spurious formants were found in both laminals and apicals, as can be seen in Appendix 8 (2). Fant found a similar problem in his analysis of vowels and he noted that" these are probably due to some degree of nasal coupling and/or subglottal coupling". (Fant, 1973 : 38-39).

2.3.1. LATERALS

The data base of laterals used in this analysis can be found in Appendix 4. Spectrographic examples in Appendix 8 (3). Figure 1 below shows the plotted values of F_1, F_2 and F_3 of the four laterals. Each F value is expressed in terms of the 95% confidence limits and the cross (X) marks the mean. The connecting line between mean values makes it easier to compare relative values.

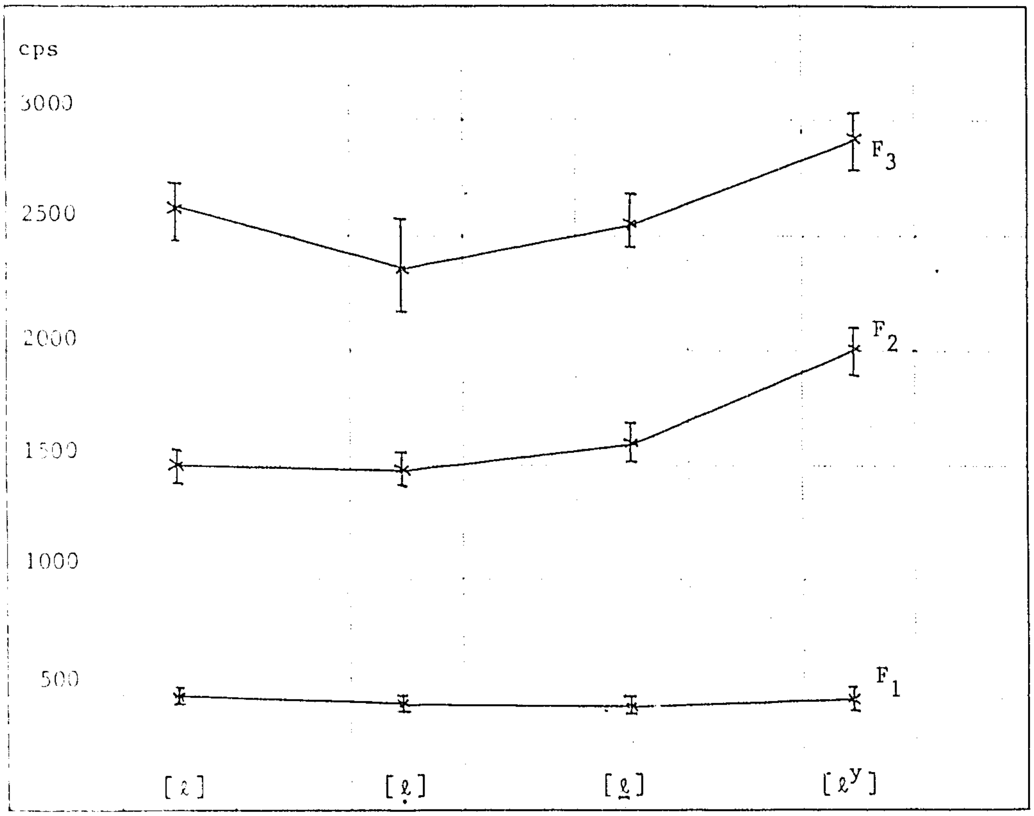

Figure 1: 95% confidence limits of laterals (X marks the mean)

It is noticeable that F_1 values do not vary significantly, whilst F_2 and F_3 have significant differences. The palatal has significantly higher F_2 and F_3 values than the other laterals. On the other hand, the F_3 values of the alveolar is higher than the retroflex although both have similar F_2 values. The dental's F_2 value is higher than that of the two apicals, though not as high as the palatal.

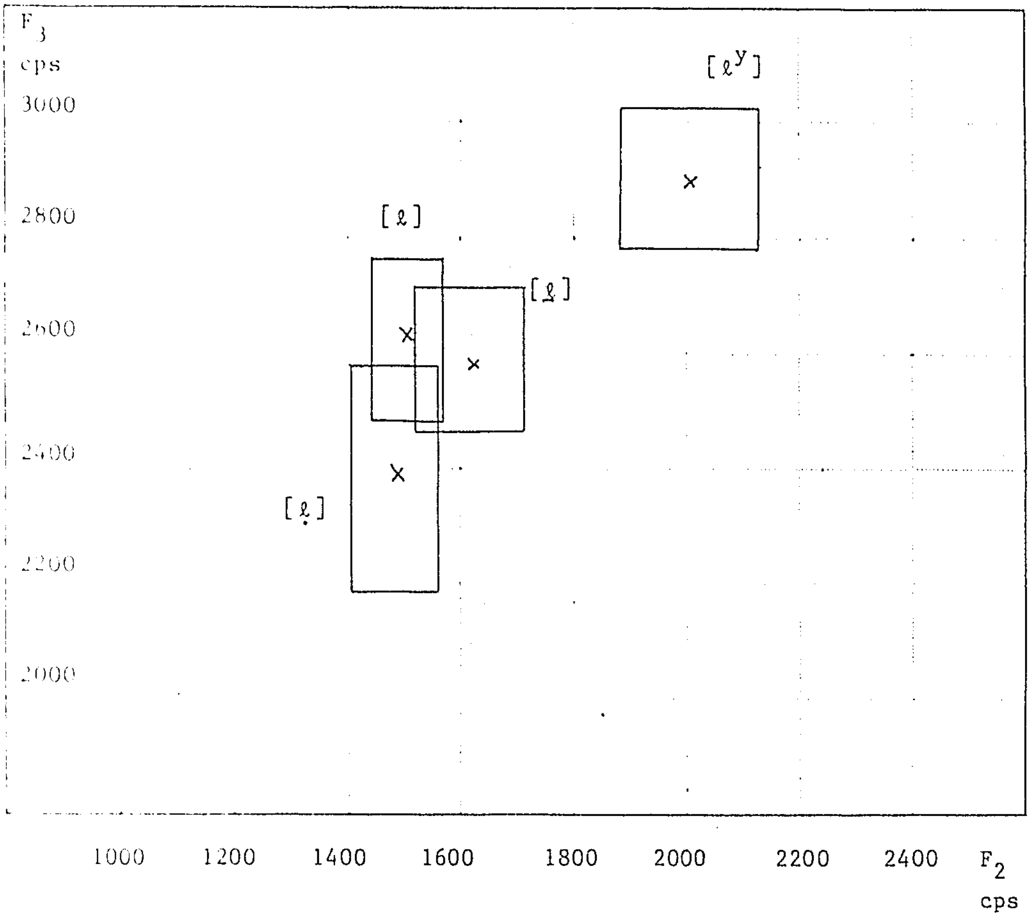

Figure 2: F_3 x F_2 95% confidence limits of laterals (X marks the mean)

Figure 2 above is the plotting of the 95% confidence limits and mean values of lateral segments on an F_3 x F_2 diagram. Two factors emerge from this type of representation. The first is that the palatal is quite distinct from the other laterals, a situation repeated in the nasal data (2.3.2. below). The second point is the degree of overlap, where it appears that some of the F values recorded for one segment were similar to the F values of another. This is the case for the two apicals and the dental. However, the overlap is on the extremities of the 95% confidence limits and thus it reflects that only a small number of examples are found, possibly an artefact of different vowel environments.

Finally, it is worth noting that the F_2 values distinguish the dental laterals from the two apicals and F_3 values distinguish the retroflex from the alveolar segments.

2.3.2. NASALS

The data base on which the analysis of nasal segments is made can be found in Appendix 5, with the spectrograph section examples in Appendix 8 (4). Nasals have a rather different set of distinguishing parameters from those found for the laterals which is not entirely unexpected. It will be noted (2.3.4. below) that the mid-F_2 range[60] of consonants, the dental, alveolar and retroflex do vary as to which actually has the numerically higher F_2 value. It is therefore not surprising that the relative order for nasals will be different from that found in laterals. Figure 3 (p. 54) is a representation of the 95% confidence limits and mean values for the six nasal segments.

The palatal nasal, like the palatal lateral, has a significantly higher F_2 and F_3 value than other nasals. However, we find the retroflex with a significantly higher F_2 value than the alveolar, unlike the corresponding laterals. It is worth noting that the F_1 values of the velar nasal and the alveolar [n] are significantly different; the latter has a lower value (see Figure 5). It appears then that one of the distinguishing parameters of the velar nasal is the relatively higher F_1 value than is the alveolar and thus the larger 95% confidence limits range of F_2 is not so significant. This

60. The low-F_2 range is the peripherals, the high-F_2 range is the palatals.

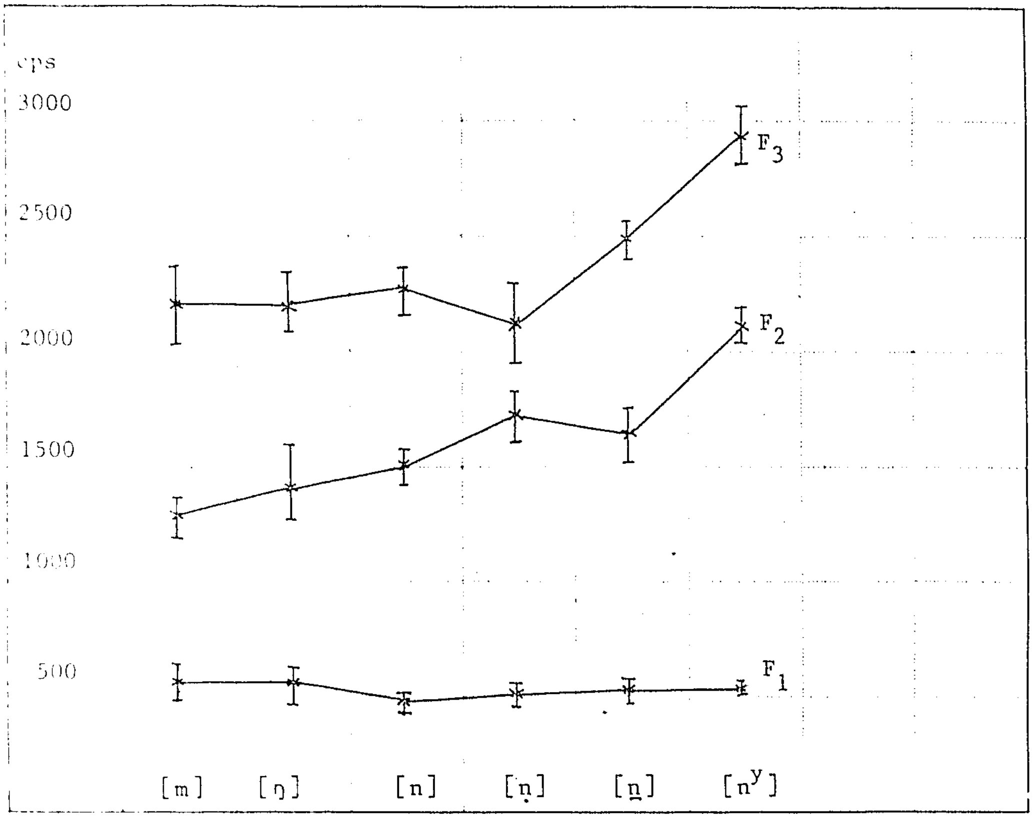

Figure 3: 95% confidence limits of nasals (X marks thé mean)

is not surprising for there is a great deal of variation in the F_2 values of velars. "This step classified all sounds into two classes; one, which we shall call the acute class, contained /t/ and /d/ and the front variants of /k/ and /g/; the other, which we shall call the grave class, contained /p/ and /b/ and the back variants of /k/ and /g/". (Halle, Hughes and Radley, 1967 : 173-174).

The following F_3 x F_2 representation (Figure 4) shows the extent of the velar overlap with the alveolar nasal. We do notice, however, that there is no overlap of the non-velar nasals. In laterals we found that the two apicals and the dental had some degree of overlap; this does not appear to be the case with corresponding nasals. We find that F_3 values distinguish the dental and the palatal from the two apicals, the F_2 values distinguish the retroflex from the alveolar. In laterals, it was noticed that F_2 values distinguished the dental from the two apicals which in turn were distinguished by F_3 values.

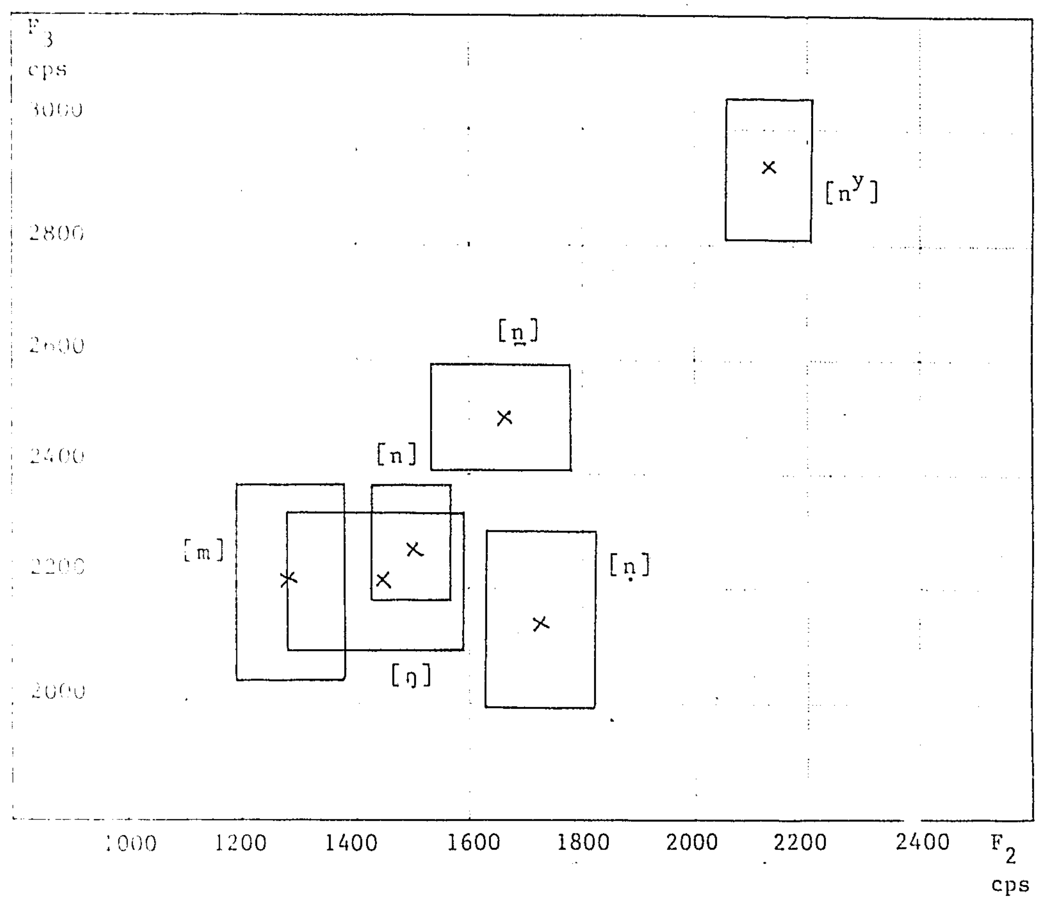

Figure 4: F_3 x F_2 95% confidence limits of nasals (X marks the mean)

Figure 5 below shows the $F_2 \times F_1$ representation of the two peripherals, [ŋ] and [m], and the alveolar [n]. It is noticeable that this shows the F_2 and F_1 values closer for the velar than for the alveolar; the former is thus more grave[61] than the alveolar and is therefore closer to the other peripheral [m], which in turn is more diffuse than the velar.

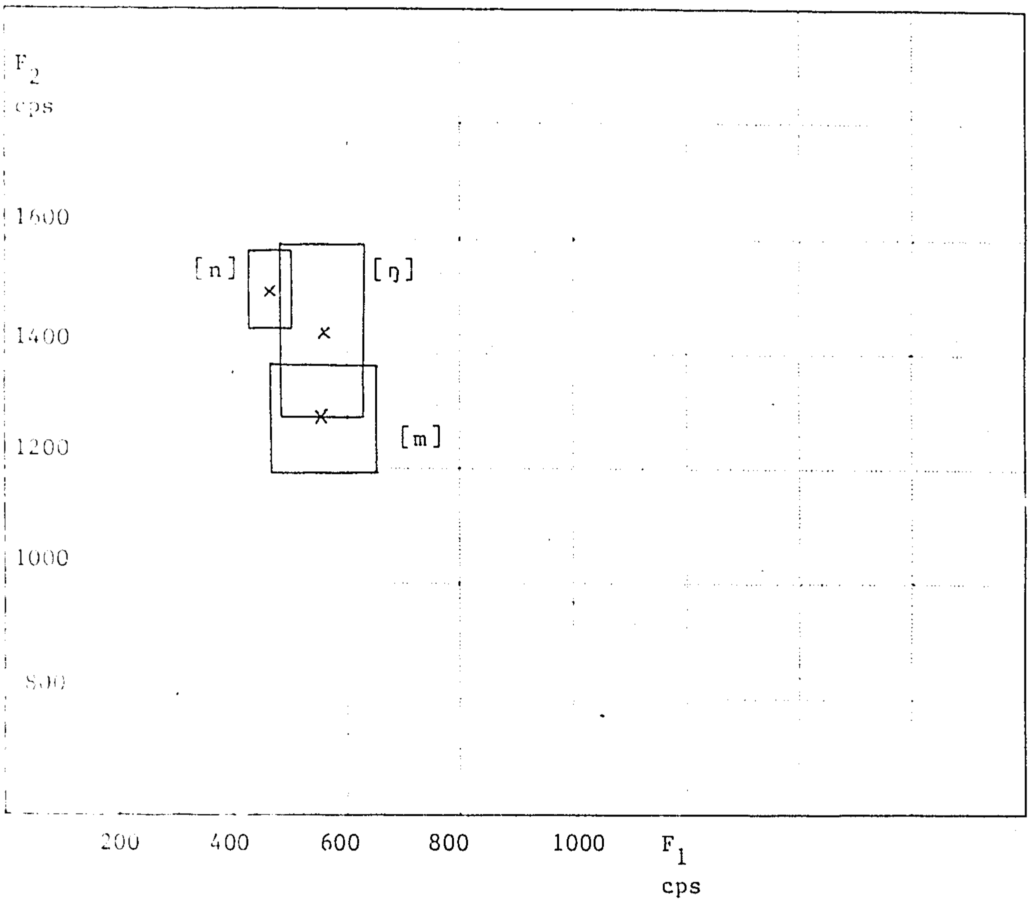

Figure 5: $F_2 \times F_1$ 95% confidence limits of [m], [n] and [ŋ]
(X marks the mean)

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61. Gravity is used in the manner specified by Jakobson and Halle, as is diffuseness (Jakobson and Halle, 1956 : 29, 31). (See also 3.1.1.1.1. and 3.4.1.1.).

2.3.3. VOWEL TRANSITIONS

It was mentioned previously (c.f. 2.2.1.) that we measured the vowel transitions adjacent to segments, this being the second method of analysis. A major characteristic that distinguishes stops from sonorants is the presence of a silent period, with or without F_o, and thus an absence of formants. "This silence is a necessary cue for the perception of a stop sound: if the silence is filled with any other type of sound except voicing, a stop is not perceived". (Halle, Hughes and Radley, 1967 : 170). We therefore find the method of analysis used for laterals and nasals unsuitable.

However, it has been noted that "the acoustic cues that distinguish the columns of the figure (i.e. b-p-m from d-t-n from g-k-ŋ) are the direction and extent of the rapid shift in the frequency position of the second (higher) formant" (Liberman, Delattre, Gerstman and Cooper, 1967 : 159). In other words, the second formant transitions of the vowels surrounding the segment are an acoustic cue that perceptually distinguishes the bilabial, alveolar and velar positions of articulation. Malécot observed the same results, for the formant transitions of adjoining vowels served as "place cues indicating whether a phoneme is labial, dental or velar" (Malécot, 1956 : 281).

Aboriginal languages have a maximum of seven articulatory places excluding the glottal stop, for stops and nasals; four for laterals. Therefore, differentiation by F_2 transitions of adjacent vowels will be more discrete. Due to the lack of sufficient data on the palato-velar stop and nasal, they are excluded from this general analysis, as they were from the nasals (however, see 2.3.4.1. below).

The use of F_2 transitions to determine the differentiation of positions of articulation for stop, nasal and lateral segments will not only be a method of distinction but will also shed light as to the validity of the theory. The results, however, are only suggestive. The non-peripheral stops made in front of the soft palate, the dental, alveolar and retroflex interchange in the relative F_2 loci for stops. Palatal stops have the highest F_2 loci in all cases excepting -ud^y- (see 2.3.3.3. below) and the peripheral stops have descending transitions with the lowest F_2 loci. The bilabial stop is equal to or lower than the velar in all cases. Nasal and lateral transition results are relatively fixed in comparison to the stops because they involve a different set of measurements as set out below.

We do not, however, find that F_2 transition values distinguish all sounds; the mean values and their 95% confidence limits are non-distinctive in the mid-F_2 range (c.f. the dental, alveolar and retroflex places of articulation). Therefore F_2 transitions are an indicative source of stop differentiation, though not the only one (see 2.3.4. below).

The method of analysis of stops involved two sets of measurements: the first is the steady state of the vowel; the second being the end of the transition. "This is not an unambiguous process. The first part of a transition after the release may be very rapid and difficult to follow". (Fant, 1973 : 121). These two sets of measurements are labelled S (start) and A (the end of the transition). In our figures of stop transitions we also find a third point, B, where the distance A-B is one half the distance between S and A. This third point is a projection of the measured S-A transition and incorporates the "locus" theory of vowel transitions. (c.f. Detattre, Liberman and Cooper, 1967 : 283-287). The transition locus involves the concept of the transition moving towards an optimum frequency. Perception tests have shown that the "best silent interval is approximately half the total interval" (Delattre, Liberman and Cooper, 1967 : 286); where the interval is the time distance between the stop loci and the start of the transition.

By the extension of the transition to its perceptually maximal point B, we may assume that the locus of the stop is between points A and B inclusive. This because the transition would not reach its locus in speech; in rapid speech the transitions are even less likely to. By standardizing the transition durations we can examine the optimum transitions and loci which would not normally be clear in varying speech speeds. The duration of the transition and the silent interval is a proportional relation; the standardization of our projections thus controls the influence of the speed of the utterance.

Nasal and lateral transition analysis involves only two sets of measurements. The first is the steady state of the vowel, marked again by point S. As we already know the formant frequencies of the laterals and nasals we do not need to use transition projections and thus point A represents the already determined formant frequency.

Finally, only three vowel environments are considered; [i], [a] and [u], for all three occur in all languages.[62] Each segment is measured preceeding the vowel (marked by C/——V) as following (C/V——). The acoustic data of stops, nasals and laterals for each vowel environment at points S and A are found in Appendix 6. Spectrographic examples of stop transitions are found in Appendix 8 (5).

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62. Kaititj is not an exception by having two morphophonemic vowels /a/ and /ə/; for phonetic realizations include [i], [a] and [u].

2.3.3.1. The Environment [a]

The transitions of C/a—— and C/——a of stops, nasals and laterals are shown below (Figures 6, 7 and 8). F_1 transitions in all sets of data do not appear to be distinctive.

F_2 transitions have a distinguishing function and we can make two divisions. The marked downward transitions of the peripheral nasals and stops form one group. The level and upward transitions of non-peripherals is the other group. The direction of F_2 transitions of nasals and lateral segments are relatively predictable in light of the spectrographic evidence already presented (c.f. 2.3.1. and 2.3.2. above). However, we notice that the relative order of F_2 values, from highest to lowest, for laterals varies according to vowel environment:

C/a——	C/——a
ℓ^{y}	ℓ^{y}
ℓ̣/ℓ̱	ℓ̱
ℓ	ℓ
	ℓ̣

This same type of variation is found at point B of the stops, where we find the following rank order from highest to lowest:

C/a——	C/——a
d^{y}	d^{y}
ḍ/d	d
ḏ	ḏ/ḍ
g	g
b	b

Figure 6: Stop transitions (mean values only)

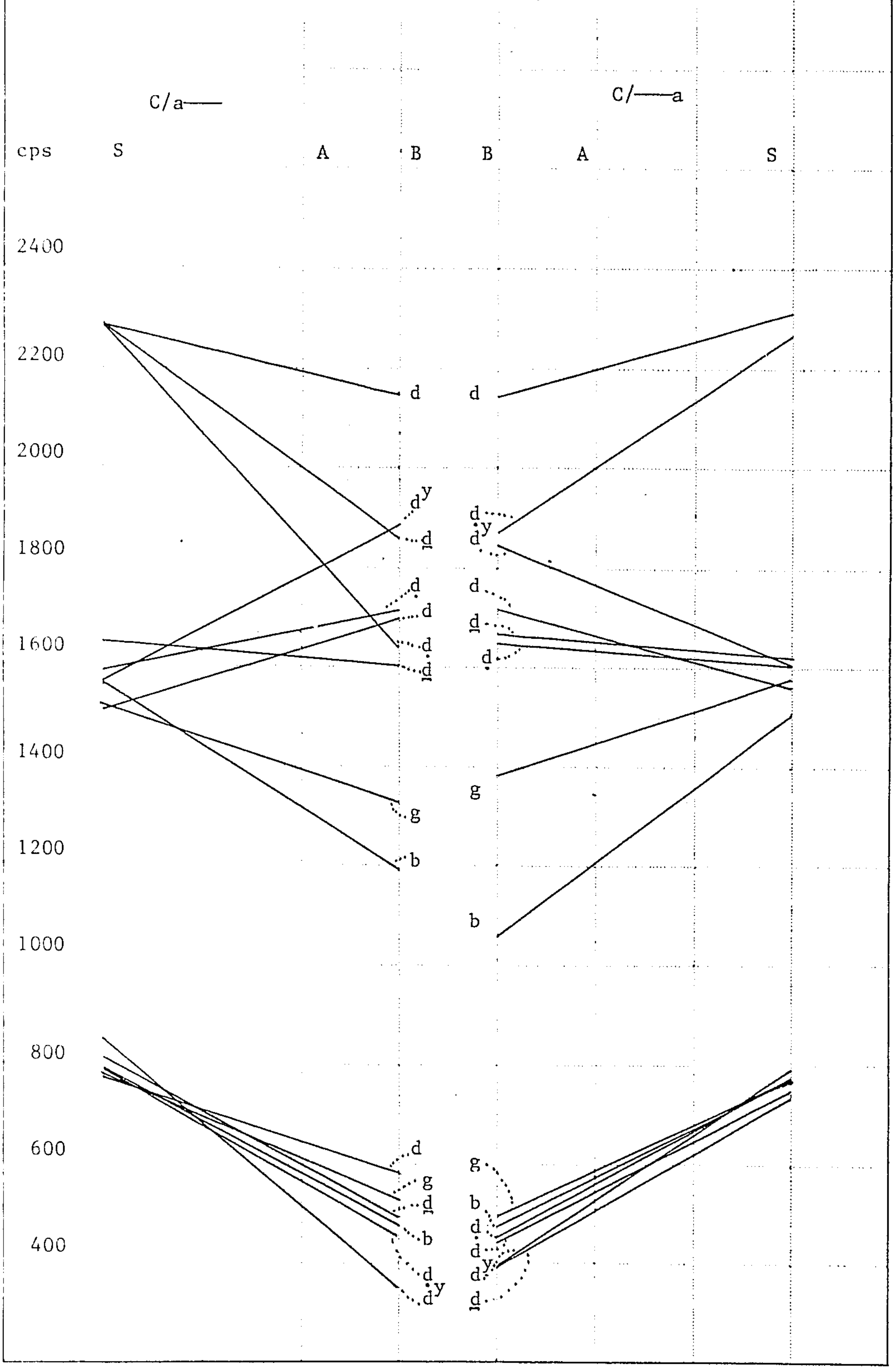


Figure 7: Nasal transitions (mean values only)

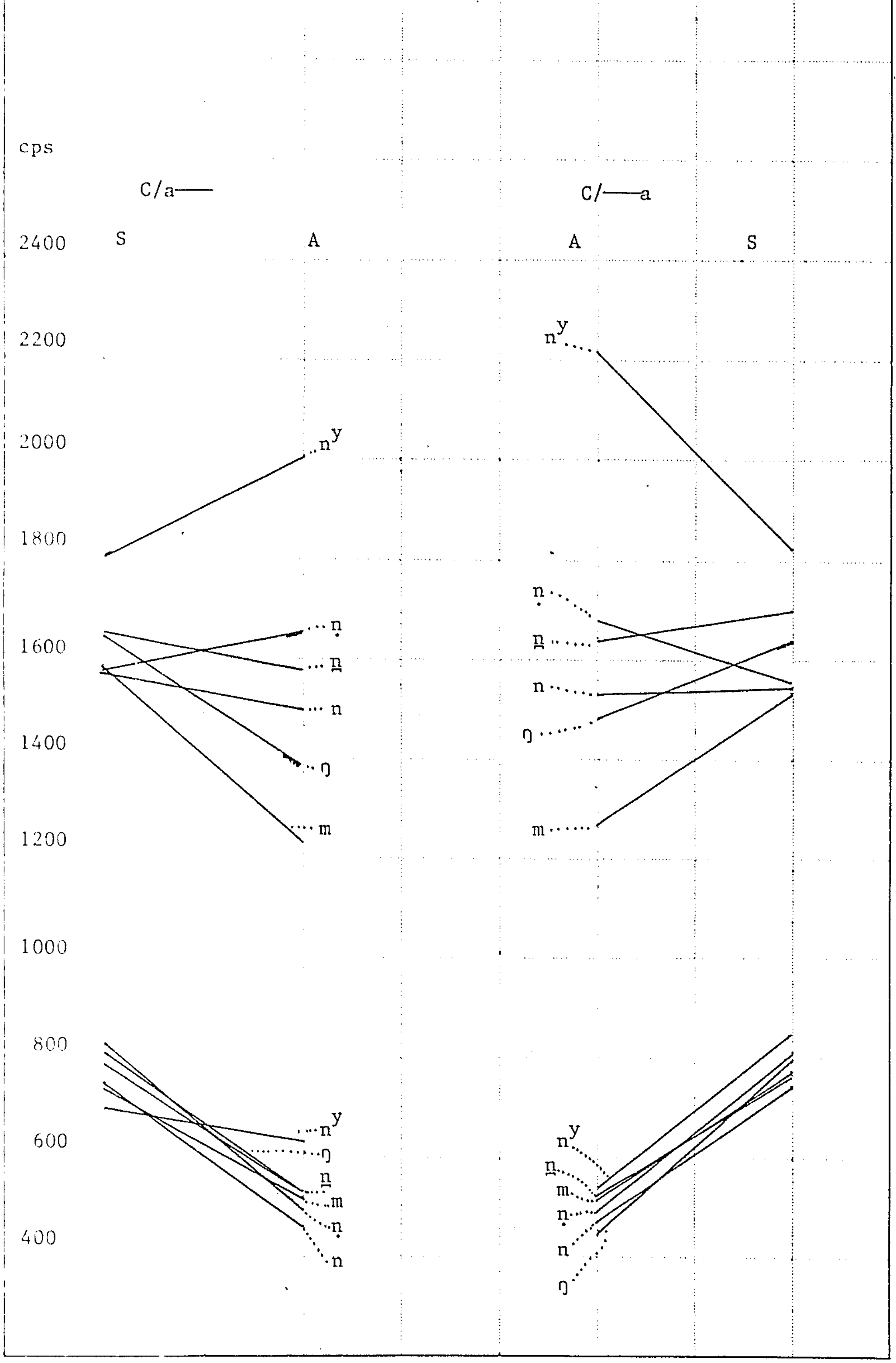
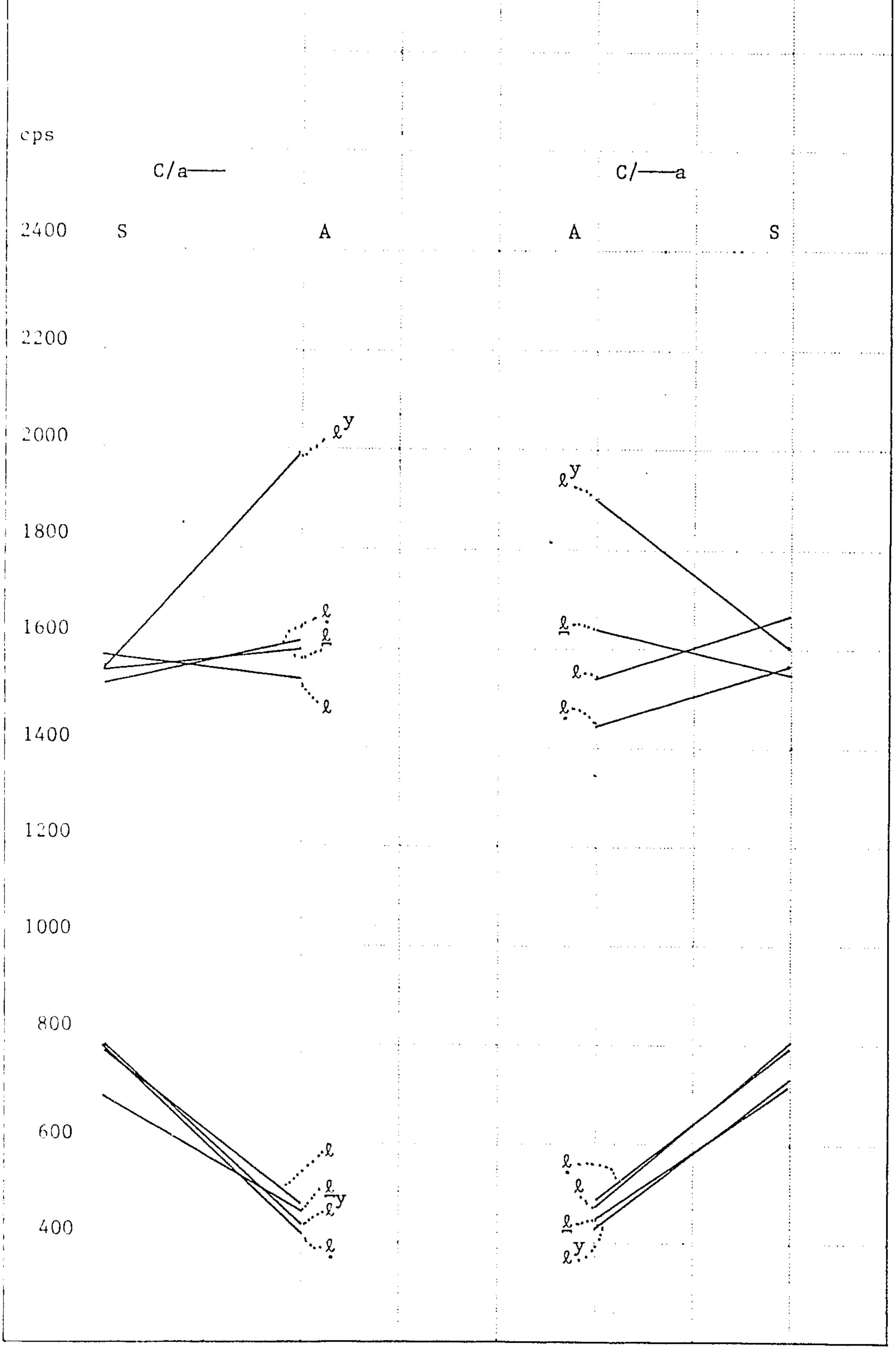


Figure 8: Lateral transitions (mean values only)



Nasals, on the other hand, hold the same relative values:

C/a——	C/——a
n^y	n^y
ṇ	ṇ
n̪	n̪
n	n
ŋ	ŋ
m	m

In all three manners of articulation we find that the palatal has the highest relative F_2 values. F_3 transitions in stops show that the retroflexes have a more marked lowering than the alveolar or dental. F_3 values are uncommon, as will be seen in other vowel environments and thus the claim of relative values in this respect are tentative.[63] For instance, in the C/a—— environment, the sample number of apicals was three, with dentals only one case was recorded.

2.3.3.2. The Environment [i]

Figures 9, 10 and 11 below show the mean value transitions of the first and second formants for stops, nasals and laterals. It is interesting to note that the least marked angle of descent is found in the palatal segments; the most marked angle in the peripherals. The direction of F_1 transitions of nasals and laterals are worth noting. In the [i] environment we find an upward transition of the first formant, whilst in the [a] and [u] environment the trend is for a downward and mixed direction respectively. Stops in the [i]

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63. The third formant of vowels is typically low in intensity in our data thus F_3 transitions cannot be considered in full. (See also 3.4.1.2. below).

Figure 9: Stop transitions (mean values only)

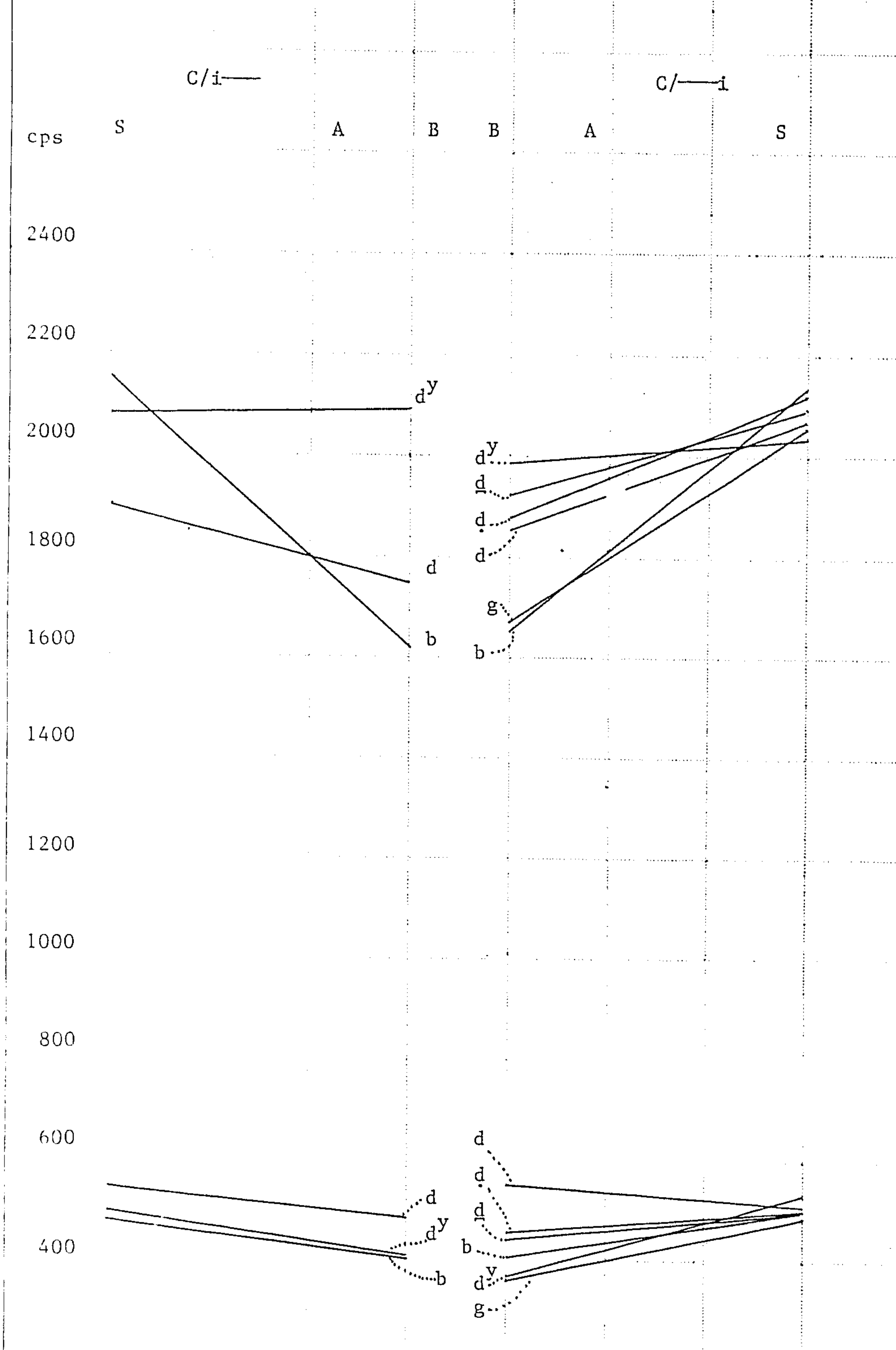


Figure 10: Nasal transitions (mean values only)

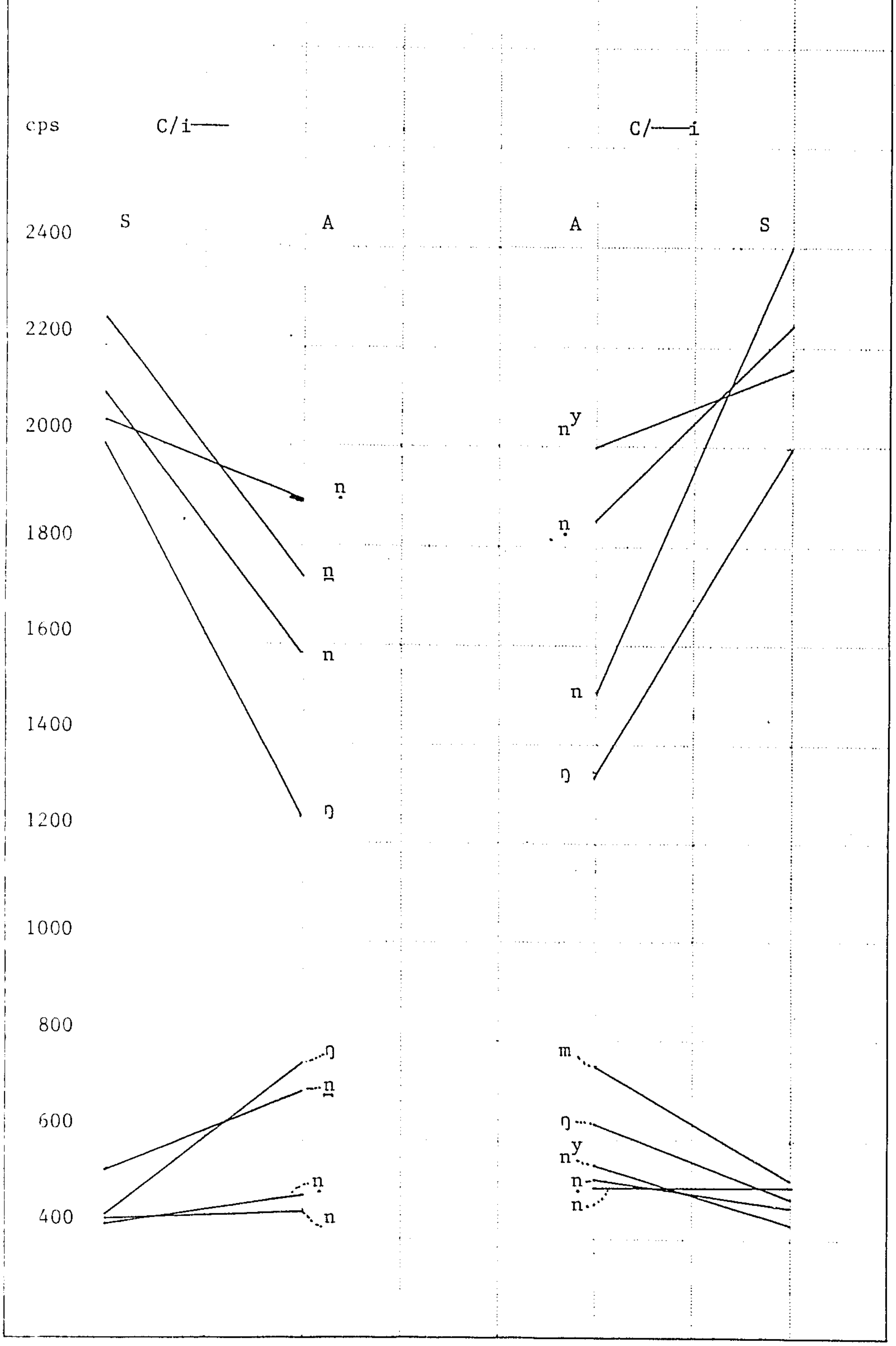
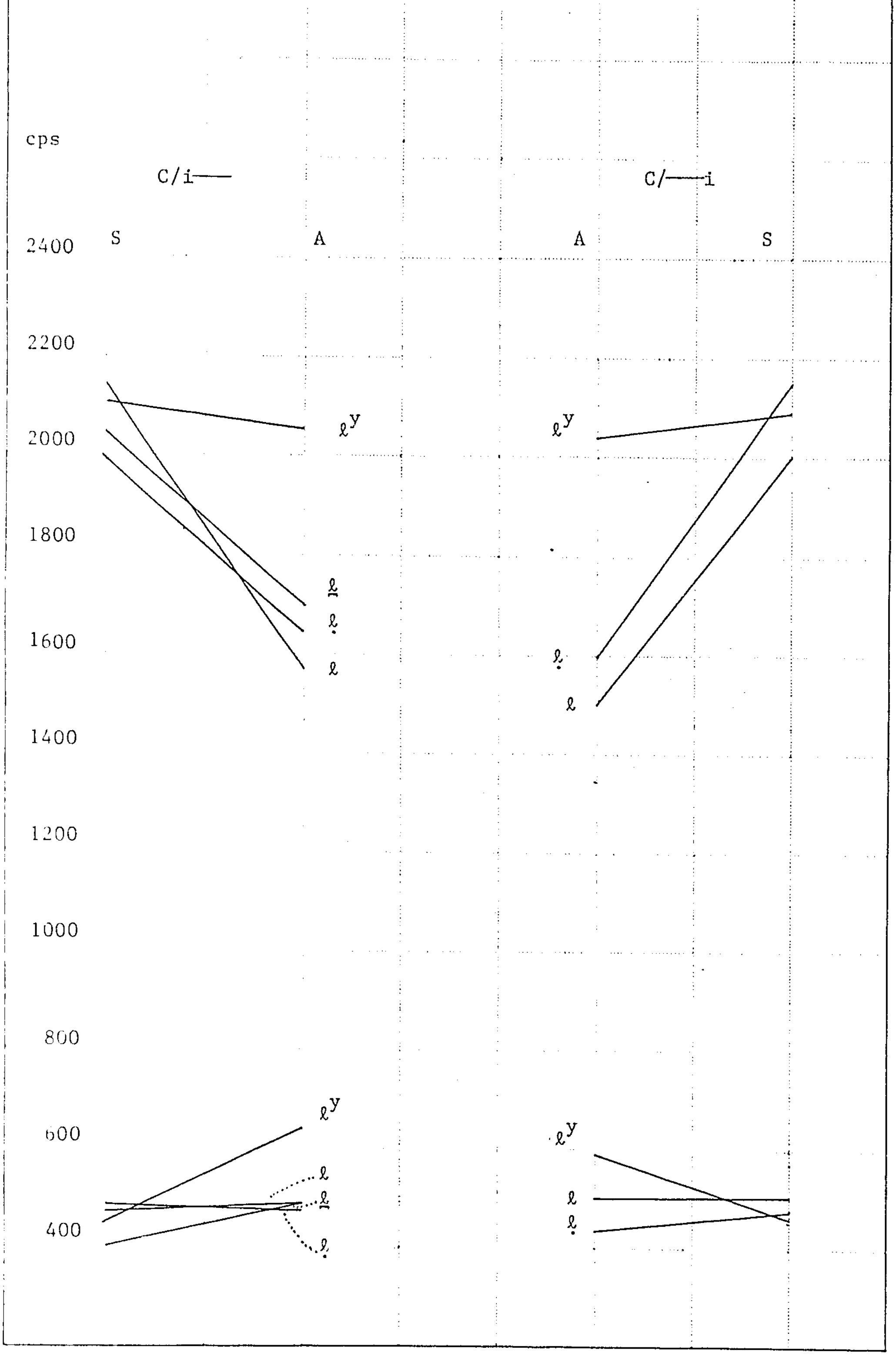


Figure 11: Lateral transitions (mean values only)



and [u] environment tend to have level to slightly falling F_1 transitions and in the [a] environment show the same downward transition as was found in the nasals and laterals.

2.3.3.3. The Environment [u]

Figures 12, 13 and 14 below show the transitions of stops, nasals and laterals in the vowel environment of [u].

We notice that the palatal stop in the C/u—— environment occupies the lowest upward transition position. There appears to be no explanation for this anomaly although the sample size of six or perceptual confusions may be influential factors (see also 2.3.4. below).

It is interesting to note that the peripheral stops show a downward transition whilst the equivalent nasals have an upward transition. The bilabial nasal [m] and the alveolar [n] surprisingly have the same transitional angle and relative F_2 value in this environment of C/u——.

2.3.3.4. The Glottal Stop

In Appendix 8 (6) we find an appropriate example of the glottal stop. Since the glottal stop involves no articulatory modification in the oral cavity[64] we find no modification of the surrounding formant patterns.[65] The vowel formant patterns are simply interrupted, the period of silence indicating the state of glottal closure.

64. Hence Ladefoged's use of the feature [Glottal Structure] (see 3.1.1.3.).

65. Jakobson and Halle mark the glottal stop by having a minus value for all articulatory features, the evidence is in agreement as there is no modification in terms of position of articulation (see also 3.1.1.1.).

Figure 12: Stop transitions (mean values only)

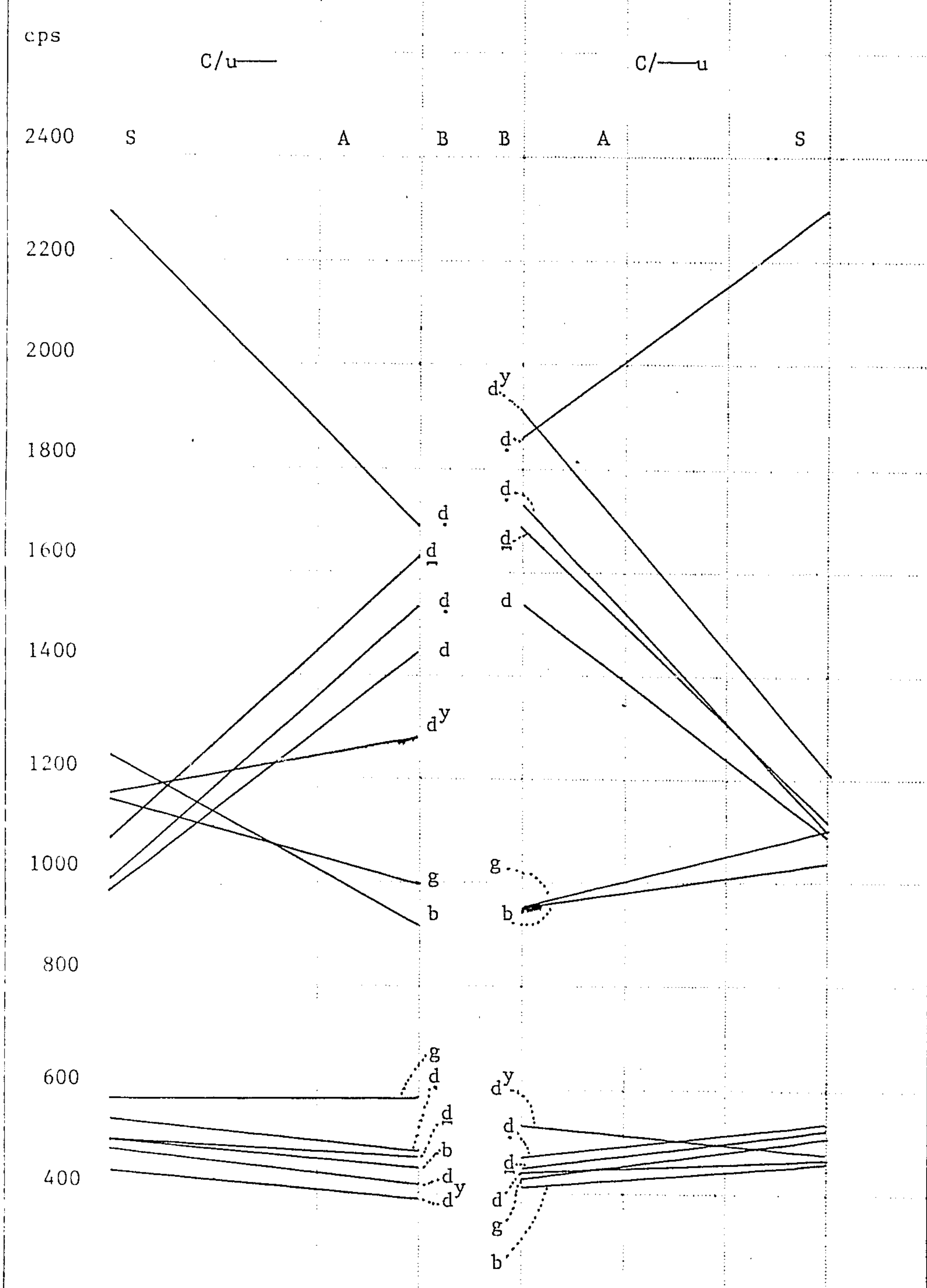


Figure 13: Nasal transitions (mean values only)

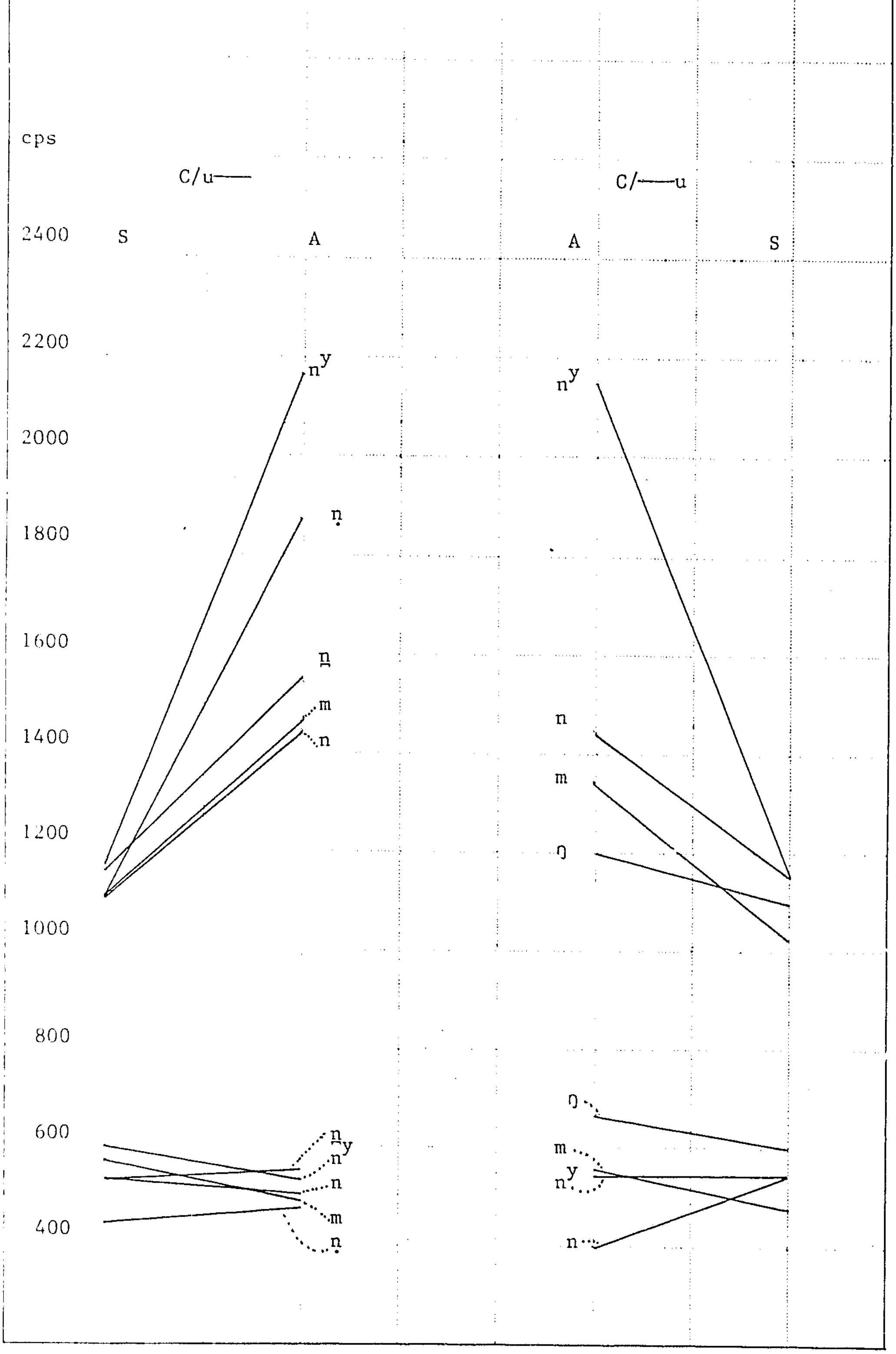
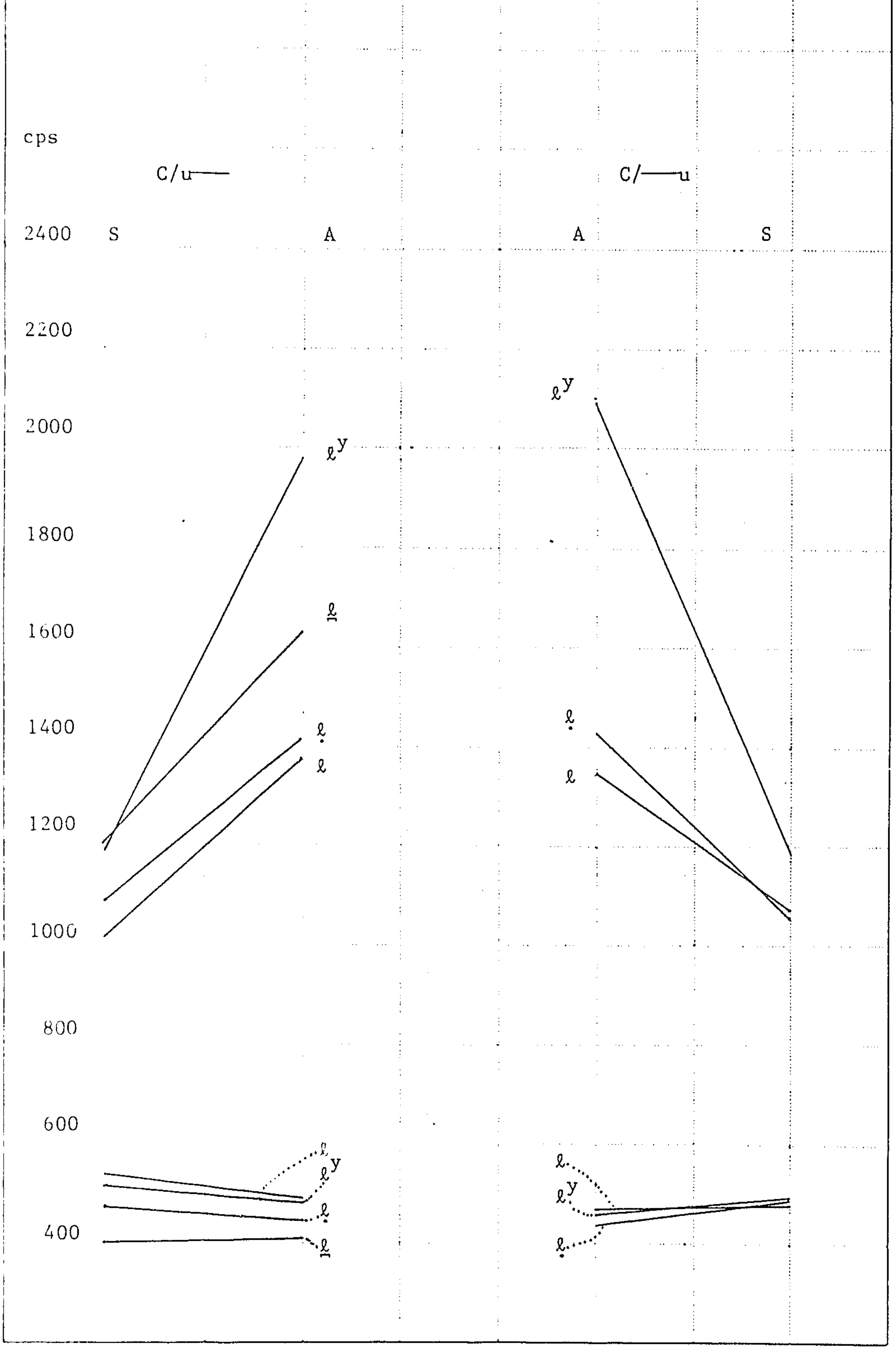


Figure 14: Lateral transitions (mean values only)



2.3.4. POSITION OF ARTICULATION CORRELATES

We mentioned earlier (2.0.) that we cannot assume that the same acoustic correlates will apply for all manners of articulations examined so far, but we do not expect them to be vastly different. There is one correlation that stands out in our analysis; the three levels of F_2 values. In the low-F_2 range we find the peripherals; the mid-F_2 class contains the two apicals and the dental; and the high-F_2 range contains the palatal. We cannot, on F_2 values alone, distinguish the mid-F_2 class members.

It is of interest to compare the transition projections used in perceptual tests (Delattre, Liberman and Cooper, 1967 : 284) with those projections recorded in our data. We find agreement with the bilabial and alveolar points of articulation but differences in the velar. Delattre, Liberman and Cooper propose an upward transition for a velar preceeding the vowel [i] whilst a downward transition was recorded in our data.

Perceptual anomalies were noticed in the analysis of the data, differences between the transcription and my perception; and it is worth noting the results of a transcription exercise performed by trained phonetic students[66] on a sample of 52 short utterances in Murinbata. Of these 52 words, 21 were transcribed differently, the predominant areas of confusion covered stops, nasals and laterals with dental, palatal and apical places of articulation. Rhotics too, presented a problem, which is not surprising considering that Murinbata

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66. Dr. David Bradley and five students participated in this exercise. The tape was played numerous times and the students' final transcriptions were compared. (Thanks are due to Dr. Bradley and the students of the B5 Advanced Phonetics class at A.N.U., 1978). As I do not have the researcher's fieldnotes I cannot correlate the two sets of transcriptions.

has two glided rhotics /R/ and /ɹ/ (see 2.4.2. below).

Synthesis and perception tests are obviously necessary in order to derive a more valid interpretation of the acoustic structure of segments in aboriginal languages.

In order to distinguish between the mid-F_2 range sounds; the retroflex, alveolar and dental positions of articulation, we need to examine other characteristics of these segments. The distinction between apical and laminal tongue positions has acoustic characteristics which help distinguish those segments in the mid-F_2 range. Fant suggested that " a high frequency extension of the noise" (Fant, 1973 : 183) may be a suitable correlate for a laminal segment; McDonald noted in her excellent study of Yaraldi that both dentals and palatals have high frequency energy (McDonald, 1977 : 45). The $F_3 \times F_2$ representations of nasals and laterals (Figures 2 and 4 above) for instance, show that the dental is proportionally closer to the palatal than the apicals are, and thus the dental has higher frequency envelopes in such a representation. The palatal naturally has the same high envelope but it is more marked (see also 2.8.2. below).

The distinction between apicals appears to rest in either the F_3 or F_2 values of lateral and nasal segments or by a more acute drop of the adjacent F_3 transitions for retroflex stops. It may be suggested that retroflexes differ from alveolars in the fact that the F_3-F_2 value will be significantly smaller for the former (c.f. Fant, 1973 : 28). Figure 15 (p. 74) shows the F_3-F_2 values of the two apicals, both the nasals and the laterals. The data is set out on the following table.

Table 4: F_3-F_2 values of Apical Nasals and Laterals

Segment	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
					lower	upper
l	15	1073	322.32	83.22	910	1236
ḷ	10	883	323.40	102.27	683	1083
n	18	784	213.62	50.35	686	883
ṇ	10	400	388.01	122.70	160	640

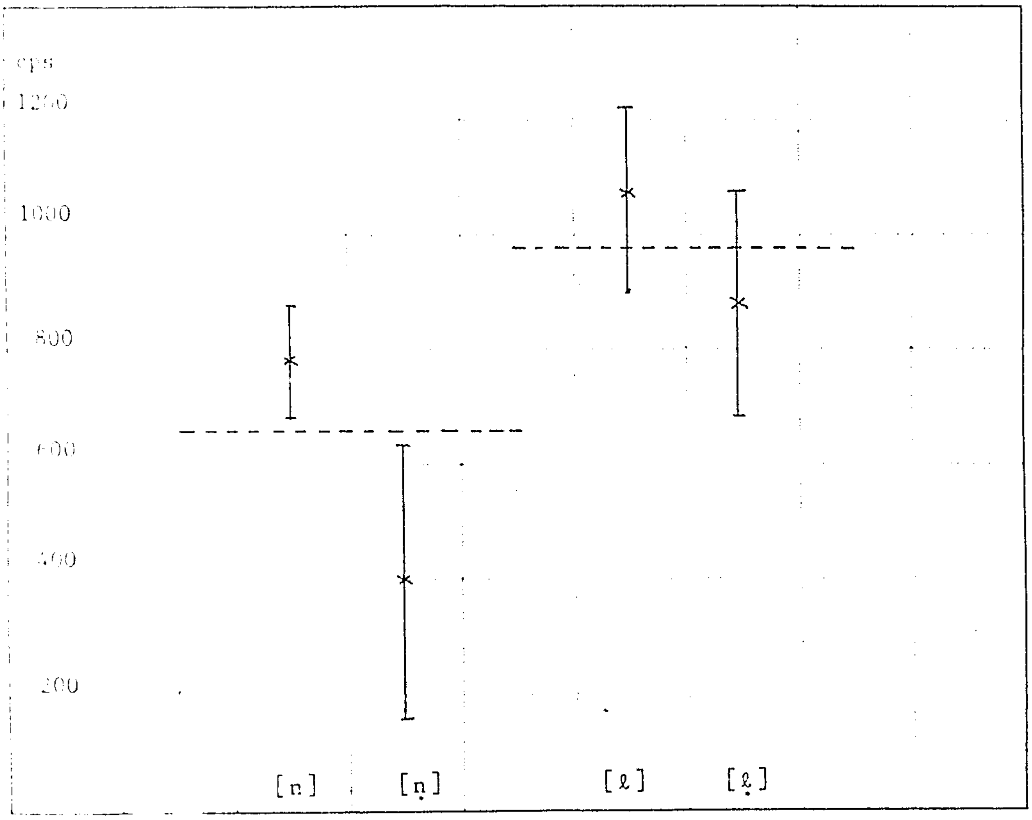

Figure 15: F_3 - F_2 95% confidence limits of apical nasals and laterals (X marks the mean)

The evidence, however, is not absolutive and is thus only suggestive of the acoustic distinction. What we do find, however, is a plunging F_3 of adjacent vowels for all retroflexes: nasals, stops and laterals. It is therefore the evidence of stops that present the more accurate analysis (some examples are found in Appendix 8 (7)). We must therefore disagree with McDonald who states that the F_2 of retroflexes is typically lower than for apicals. (McDonald, 1977 : 44).

Retroflexes, like alveolars and dentals, belong to a central, mid-F_2 class in which the distinctions are marked by higher frequency envelopes for the laminal dental and a plunging F_3 of vowels surrounding a retroflex.[67]

2.3.4.1. The Palato-Velar

The scarcity of the palato-velar position of articulation is manifested in two manners. Firstly, it occurs in only four languages, of which two lack the nasal counterpart (c.f. 1.1.1.5. above); and secondly, it is apparently a rare occurrence within the languages themselves.

Djingili and Yanyula are two languages included in this study which contain the palato-velar in their phonemic inventory. In Djingili a nasal palato-velar [ŋj] was found in spite of the fact that it is not recognised phonemically (Chadwick, 1975 : 2). The word in question is "skin": /gurn^{y}u/ (Chadwick) and [gurŋju] (Hale).

Acoustically, we find the following formant structure, the spectrographic section can be found in Appendix 8 (8); F_1 = 500 cps, F_2 = 1375 cps and F_3 = 2600 cps. The F_1 and F_2 values fall within the 95% confidence limits of both peripherals. The F_3 value, however,

67. Notice that this implies that the alveolar position has no specific defining characteristics, a claim in agreement with Dixon's analysis of articulatory place features (sec 3.1.1.4. and 3.2.0.).

is significantly higher than that recorded in the velar, as high as the upper limit of the dental nasal. We can thus see the effects of palatalization as a raising of the upper frequency components. The formant transition values of the nasal palato-velar are as follows:

S-Position	F_1 = 420 cps	A-Position	F_1 = 500 cps
	F_2 = 1010 cps		F_2 = 1375 cps

We notice that the F_2 value is slightly higher in its transition when compared to the velar nasal, but not significantly so. We also notice a higher F_2 transition in the palato-velar stop in Yanyula.

In Yanyula we found one example (see Appendix 8 (8)) of the palato-velar stop. The phrase "my nose itches" was transcribed by Hale as [d^{y}aṇaŋurunan^{y}d^{y}i] whilst I believe it to be [gjaṇaŋurunan^{y}d^{y}i]. At point A, the end of the measured transition we find the F_1 value of 600 cps descending from an S-Position of 700 cps. F_2 is an upward transition from S-Position 1500 cps to A-Position of 1600 cps. In comparing these values with the mean values of stops in the environment C/——a (Figure 6 above) we find that the upward projection of F_2 distinguishes the palato-velar from the velar. The transitions of the palato-velar nasal, as we noted above, are not distinctive in their own right.

However, with only two examples in all the data analysed, these distinctions are only suggestive of the nature of the palato-velar position of articulations. Obviously more study on a larger sample is needed.

2.4.0. RHOTICS

We notice on Table 1 above that rhotics fall into three separate manners of production; the flap, the trill and the glided rhotic. The flap and trill form a single group on the basis of their allophonic alternations in some rhotic systems (c.f. 1.1.11.1. and 1.1.11.2.) and differ in manners of articulation. The two glided rhotics can be placed in another group as they differ in terms of position of articulation.

2.4.1. FLAPS AND TRILLS

The spectrograph examples (Appendix 8 (9)) show the nature of the manner of articulation of flaps and trills. In the [i] environment of [n^{y}iri] (Arabana) we notice the rapid lowering of the second formants of the vowel. The rate of descent and the time lapse of the silent period appears to be shorter for the flap than for the stop.

This is to be expected, for the flap is a rapid movement of flapping the tongue tip against the roof of the mouth. A stop is a much more complex phenomenon of a closure which is held for a period of time followed by a release. The trill apparently has the same first and second formant levels as the flap and has a series of vowel-like segments with periods of silence. The silent periods are the rapid hitting of the tongue against the roof of the mouth, the acoustic effect of which can be seen in [wařida] (Diyari).

2.4.2. THE GLIDED RHOTICS

The usual Australian glided rhotic is the semi-retroflex; the other, an alveolar is found only in Murinbata (Walsh, 1976 : 32). The spectrographic examples (Appendix 8 (10)) show the difference between the two positions of articulation. In Murinbata the examples [puR] and [ŋaɹa] show that the F_3 value is noticeably lower in the retroflex than in the alveolar. This characteristic lower F_3 is also found in other cases of the retroflex glided rhotic, [mbaRar] (Mara) is a good example.

The continuation of the formant structure throughout these two rhotics is indicative of their glided nature and is readily contrasted with the single brief silent period of the flap and the two or three silent periods characteristic of the trill.

2.5.0. GLIDES

Glides are an "approximation of two articulations without producing a turbulent airstream" (Ladefoged, 1971 : 46) and thus involve formant movement throughout their production.

The palatal glide has characteristics similar to the high front vowel [i]. It reaches a low F_1 value, below 500 cps, and a high F_2 above 1750 cps. The spectrograph example (Appendix 8 (11)) of [ya:ga] (Wilmunkan) shows that the third formant ascends from a position indiscernable from the second formant of the glide. The Pitjantjatjara example of [ŋayulu] shows a similar effect.

The glide [w] on the other hand moves towards low F_1 and F_2 values similar to the vowel [u]. [ŋaṇawada] of Yanyula and [uwa] of Pitjantjatjara show F_2 values below 1200 cps. The unrounded [ẅ] found in the spectrograph examples of Wik-Ep and Kaititj show a higher F_2 value, characteristic of the unrounded nature of this glide. In [daẅba] (Wik-Ep), F_2 appears at approximately 1500 cps whilst in Kaititj [aẅiriyl] it appears to be just below 1600 cps.

No data was available for the dental glide [y̑] in Kurama and Yinytyiparnti.

2.6.0. OTHER PHONEMIC PHENOMENA

We have discussed in this section the usual manners of production found in Australian languages; stops, nasals, laterals, rhotics and glides above, and the vowels which will follow (2.7.0.). The other phonemic phenomena are of a more restricted nature, both in the number of languages in which they occur and in the functional load they carry within those languages. The palato-velar position of articulation (2.3.4.1. above) is a good example.

These restricted occurrences, which form the basis of the secondary manners of production (c.f. 3.1.2.3. below), are phonological constructions designed to systematize various phonotactic and/or prosodic phenomenon within a language. For our purposes, the segmentalization of these phonemes into their components is beyond the scope of this study, but would prove useful in the acoustic study of languages with such phonemes and might help to determine whether a unit or cluster approach, for instance, is more appropriate.

2.7.0. VOWELS

In the discussion of vowel types and their arrangements (c.f. 1.2.0. ff) we distinguished between vowel duration and vowel aperture. We find that the former sometimes correlates with aperture differences and thus our study must examine this distinction.

2.7.1. VOWEL APERTURE

Of the maximal number of thirty-seven vowels, including long and nasalized vowels, recorded in Australian languages, we find only fifteen in our data.[68] Figure 16 below gives the mean values in a $F_2 \times F_1$ representation, the data for which can be found in Appendix 7(A). The domains specified by the endorsed areas are the more frequent vowels [i, e, a, a:, u, u:].

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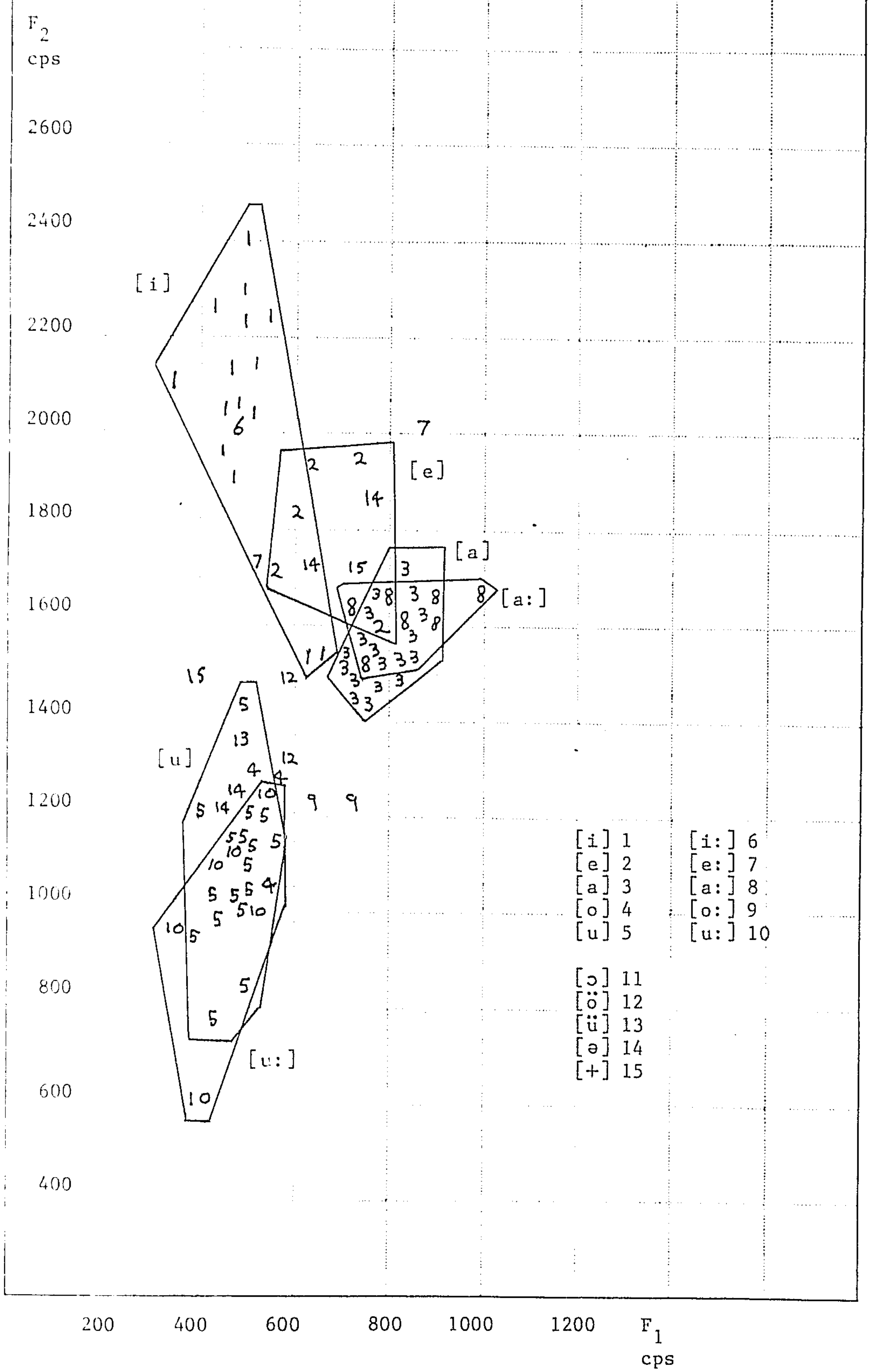
68. There appears to be a tendency for the more commonly occurring vowels of [i, a, u] to have a greater frequency of occurrence in systems of more than three vowels; possibly a reflection on the historical development of those other vowels. Of these three vowels, [a] appears to be the most common of all. However, to make a quantitative claim as to the frequency of vowel occurrence within languages and across the continent is beyond the scope of this thesis, but it is clearly observable within the data under consideration.

Figure 16: $F_2 \times F_1$ vowels (mean values only)



With one exception in both sets of long and short vowels we see that the mean values of long vowels fall within the domains of the short. This is a claim made on the basis of interlanguage analysis, given in Figur 16, and does not necessarily hold for specific languages.

The $F_2 \times F_1$ 95% confidence limits and mean values found in Appendix 7(B) are the vowel systems in each language studied. We find that the difference in long and short vowels is marked by differences in vowel positions. In Yukulta, Kuuku-Ya?u and Yanyula we find that the long vowels have different qualitative parameters than their short counterparts.[69] In Wikmunkan, two long vowel 95% confidence limits fall outside the domains of their short counterparts whilst long [a:] overlaps with [a] in quality.

Wik-Ep is in a similar situation with the long and short [a] 95% confidence limits within the same confines, but [u:] and [e:] are distinct from their respective short vowel domains. Djambarrpuynggu has separation of the domains of long and short [u], whilst [a] and [a:] overlap. Overlapping is also found in Yathaikana's long and short [a].

Overlap between different aperture segments in a language, on the other hand, also occurs in Yathaikana, where we find the single case of [e] within the 95% confidence limits of [a]. Four other languages have recordings of quality overlap in vowels. Mara and Kaititj have exceptionally low F_2 values of the vowel [i]; the mean formant values are 1532 cps and 1550 cps respectively. Kaititj also has

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69. It is worth noting that some cases are based upon a small number of examples and thus the claims are only suggestive on the basis of the evidence obtained from the data. The number of samples is listed in the Appendix.

a low schwa; F_1 at 500 cps and F_2 at 1200. Thus the overlap is the result of the data analysis of these vowels in these languages.

Note, however that on Figure 16 (p. 80) the central vowels [ə] and [ɨ] have a wide dispersement.[70] The central vowel [ɨ] in Kurtjar overlaps with both [e] and [a]; however, the mean value of [ɨ] is approximately, half-way between these two vowels and the overlap is only in the extremities of the 95% confidence limits.

In Wikmunkan the vowel [u] overlaps with [o], but only two examples of the former and three of the latter were found.

It is interesting to compare the mean formant values of vowels found in other studies in Australian languages. Blake in his Kalkatungu description gives the mean values (Blake, 1969 : 16):

[i]	F_1 500 cps.,	F_2 2100 cps.
[a]	F_1 800 cps.,	F_2 1250 cps.
[u]	F_1 475 cps.,	F_2 875 cps.

Trefry provides the following mean values, taken to the nearest whole number in his Diyari description (Trefry, 1974 : 374)[71]:

[i]	F_1 427 cps.,	F_2 1735 cps.
[a]	F_1 637 cps.,	F_2 1351 cps.
[u]	F_1 444 cps.,	F_2 1044 cps.

70. This may be considered a suggestion that their specific vowel aperture position is not their only characteristic for they can be regarded as lax vowels (c.f. 3.2.0.). Note that we do not find these two vowels phonemically distinct in the one language, thus the choice of symbol to represent a central vowel is possibly an arbitrary choice of the researcher and not necessarily a statement about the phonetic properties of the phoneme.

71. Trefry also reports overlap on the basis of vowel spectra (Trefry, 1974 : 375-383); the data from Austin's informant does not appear to have this problem.

The mean values of Diyari in this survey are:

[i] F_1 473 cps., F_2 2046 cps.

[a] F_1 735 cps., F_2 1584 cps.

[u] F_1 477 cps., F_2 1142 cps.

In Diyari, the F_2 value of the vowel [i] is notably lower in Trefry's analysis, close to that found in Kaititj and Mara; both languages recording overlap with this vowel [i] with other vowels in their systems. Both Blake's and Trefry's mean formant values fall within the domain given in Figure 16 with the exception of the [a] vowel in Kalkatungu which has a lower F_2 value than any found in our data.

2.7.2. VOWEL LENGTH

In order to determine whether any vowel quality has an intrinsic length proportion in the comparisions of the durations of long and short vowels, it was decided to compare only those long vowels which have a short counterpart in each language. The results show that the proportional duration of long vowels to short is remarkable uniform as the following data summary specifies.

Table 5: Statistical Data on the Proportion of Long to Short Vowel Durations.

				95% confidence limits	
n	$\bar{x}$	s.d.	S.E.	lower	upper
16	2.17	0.21	0.05	2.06	2.28

Note that the sample number of sixteen is the number of matched pairs of long and short vowels of the same quality. The actual number of vowels measured was 178, of which 137 were short and 41 long.[72]

Long vowels were 2.17 times as long as their short counterparts. It is important to deal in terms of proportion as opposed to absolute values, for the latter is dependant upon the rapidity of the speech utterance. Note that the measurement is of the duration of an unchanging formant structure, ignoring transitions and glides; a process not entirely unambiguous.

2.8.0. ARTICULATORY CORRELATES

The aim of this part will be to briefly examine the evidence presented by articulatory phonetics in relation to the acoustic correlates of places of articulation (notably 2.3.4. above).

It has been the general practice in phonological descriptions of Australian languages to distinguish between peripherals, apicals and laminals; a practice continued in this thesis. We have found seven positions of articulation, excluding the glottal stop: two or rarely three peripherals, two laminals and two apicals. Two suitable phonological descriptions serve as the basis for discussion, Dixon's comments on phonology in general (Dixon, 1972 : 2) and Chadwick's description of Djingili phonemes (Chadwick, 1975 : 3-4).

It should be noted that in this discussion reference to specific manners of production will be at a minimum. Therefore, no mention, for instance, of voice or voiceless production is made (c.f. 1.1.0. above); affrication on the other hand is an important aspect and will be included (c.f. 2.8.2. below).

72. This is ag .n a suggestive factor that long vowels are less frequent than short vowels; a claim only valid for the data analysed and a tentative suggestion about proportion of long versus short vowels within Australian languages. The proportion of long vowels to short is 1:3.3.

2.8.1. PERIPHERALS

The three peripherals recorded, [b], [g] and [gj] have been described in the following manner (Chadwick, 1975 : 3-4):

[b] Bilabial stop. No affrication.

[g] Dorso-velar stop. No affrication.

[gj] Palato-velar stop. Onset by contact of back of tongue with from of velum wich palatal release.

It is interesting to note that in the palatographic description of [g], "the articulator is dorsal or even radical and the place of articulation varyingly velar or (post) palatal" (Jernudd, 1974 : 99). This large articulatory position range is supportive of the acoustic description of the velar nasal which results in a large F_2 range (see also 2.3.2. above).

[illegible]2. LAMINALS

Djingili has only one laminal, the palatal, described as a [illegible] alveolar stop. Tongue contact with the blade of the tongue, [illegible] with slight affrication when released". (Chadwick, [illegible]). Dixon has described both laminals in the following manner. [illegible] case of lamino-dentals, teeth are slightly apart and the blade of the tongue touches both teeth, with the tip the tongue somewhere in the region of the lower teeth-ridge. For lamino-palatal/alveolar, the blade of the tongue touches the hard palate, or the alveolar ridge, or often both, with the tongue tip usually touching the teeth". (Dixon, 1972 : 2).

Palatographic evidence supprts these descriptions of the palatal. "The major characteristic of these imprints [n^y] and [d^y] is that they cover a large area, extending from the teeth back up the palate centre line to a depth of more than 25mm. (over the alveoli and (pre) palatal areas). The imprints cover the side of the teeth, but vary between informants and articulations as concerns covering the front teeth" (Jernudd, 1974 : 97).

The effect of this coverage of a large area is paramount in the characteristics of laminality. The removal of the tongue blade from a comparatively large area of the mouth roof is more likely to cause friction. Also the blade is a less accurate, less mobile articulator than the tongue tip, thus a larger area of coverage and a slower release. The affrication of the Djingili palatal and the high energy noise in Yaraldi (McDonald, 1977 : 45) are manifestations of the articulatory use of the blade of the tongue.

2.8.3. APICALS

[d] Alveolar stop. Similar in alveolar contact to Standard British English /t, d/ but with tongue contact nearer the tip than in English. No affrication.

[ḍ] Retroflex stop. Pronounced with underneath of tongue tip on or just behind the alveoli. No affrication (Chadwick, 1975 : 3).

Palatograms show that the alveolar has tongue contact further forward on the mouth roof than for the retroflex. The alveolar "imprints indicate an articulation which is precise and well defined, at a place of articulation at or just behind the teeth, at least not further back than at the alveoli" (Jernudd, 1974 : 97). Retroflexes, on the other hand, have imprints which "are band-formed and placed well behind the front teeth" (Jernudd, 1974 : 98). Retroflexes also involve the underneath of the tongue tip, contrasted with the alveolar articulation by the top of the tongue at or near the tip.

It is worth noting the evidence suggested by tongue-pressure analysis when comparing the alveolar with the palatal in Walpiri. "For the /tj/ sound, tongue tip position is lower than it is for /t/. The tongue tip is more directly behind the incisors for /tj/ rather than up against the palate[73] as it is for /t/" (Proffit & McGlone, 1975 : 212). In other words, the articulation of the alveolar is dependant upon the tongue tip, the palatal upon the blade. We thus find the differences in tongue pressure suggested by the relative positions of the tongue tip.

2.8.4. F_2 Pattern Relations

Two aspects of the relation between F_2-patterns and articulatory positions are noted. Firstly, we found three classes distinguishable by relative F_2 values (see 2.3.4. above). The low-F_2 class contained the peripherals, the mid-F_2 class the dental and the two apicals and the high-F_2 class the palatal. It is noticeable that the mid-F_2 range sounds correspond to a small area around the dental/(post) alveolar region of the roof of the mouth. The palatal, being the sole member of the high-F_2 class is further back in the palatal region. The peripherals are at either end of the passive place of articulation, the lips and the velum.

These F_2 classes appear to correlate with the passive place of articulation, the roof of the mouth, and the upper lip for the bilabial. The active articulator has differing acoustic effects, not necessarily correlated with a formant level. We notice, however, that the apical distinction rests upon relative F_3 values in adjacent

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73. Note that the term palate is used in a general sense, specifying the area behind the dental ridge. The positioning of the pressure tranducers is indicative of this general usage (Proffit & McGlone, 1975 : 202-203).

segments: the laminal effect lies in the occurrence of relatively higher energy than in the non-laminal segments (c.f. 2.3.4. above).

Secondly, we noticed in our acoustic analysis of the mid-F_2 class of segments that the relative order within the class varied. This is correlatable with the fact that in terms of passive points of articulation there is overlap between all three, noticeable in the articulatory descriptions of the segments given above. We find that the active articulator is therefore more important in distinguishing the sounds in this area.

2.9.0. CONCLUSION

In the preceeding Section I have attempted to outline some parameters that distinguish segments. I have emphasized the positions of articulation without much regard to the manners of production. The former are in greater need of clarification than the latter, which are readily distinguishable. Nasals, for example, have a characteristic nasal formant at approximately 250 cps. Laterals have been described by "a reduction of either second, third or fourth formant intensity due to the first zero of the shunting mouth cavity behind the tongue". (Fant, 1973 : 27). Stops, rhotics, glides and vowels have been briefly described in the text.

It is however, worth noting the following comments, applicable to both position and manner of articulation description. "Indeed, on the basis of the experience of analysing all the acoustic data discussed in this work, it would seem that without knowing the sound which is being investigated, and without some previous knowedge of approximately where the formant of such a sound might be expected to be, it is impossible to make valid measurements of the formant frequencies", (Ladefoged, 1967 : 85-86).

Our emphasis on the role of the second formant in position distinctions is suggested by the results of previous analysis of non-Australian languages. The ability of such an analysis to distinguish positions across manner classes is also tested in this use of second formant levels. We are not altogether disappointed, for F_2-values distinguish the three classes of high, mid and low, irrespective of whether the manner of production is a stop, nasal or lateral. The low-F_2 class contained the peripherals, the mid-F_2 class the two apicals and the dental and the high-F_2 class the palatal.

The passive place of articulation is reflected by these relative F_2 values; the active articulator however, does not correspond directly with the third formant levels. The apicals are distinguished on the basis of surrounding F_3 transitions, where the transition is lower for the retroflex than for the apical. Laminality, on the other hand, is marked by high frequency energy and a relatively higher spectral envelope in nasals and laterals; characteristic of the use of the blade of the tongue as the active articulator.

The use of statistical manipulation of the raw data is an attempt to standardize the data in order to make it more comparable, and to minimise the effect of anomalous examples. It is also a method of recording overlap of segment specifications, for the degree of overlap of the 95% confidence limits is a reflection of the degree of similarity between two segments. However, we must note that the statistical manipulation is only a reflection of the raw data and thus can only ultimately minimize the effects of random errors and not specify the distinctive acoustic characteristics of segments alone.

3.0. DISTINCTIVE FEATURE SYSTEMS

In the first section of this thesis we saw the types of consonants and vowel phonemes that have been recorded in Australian aboriginal languages. We also saw the types of arrangements that constitute the phonologies of these languages. The organization of the phonology, as was noted earlier (1.1.0.), is traditional; for sounds are represented as junctions of places and manners of articulation (c.f. The International Phonetic Association, 1949). It will also be seen that the arrangement of the positions of articulation (c.f. Table 1) throughout this thesis reflects the feature system of Dixon (see 3.1.1.4. below).

There is another method of organization available to the phonologist, that of distinctive features, the details of which are set out below. For the purpose of this study, distinctive features can be taken as "distinctive categories or classes within a linguistic system but just like in accepted phonemic analysis it is required that they are consistent with the phonetic facts ...". (Fant, 1973 : 152). However, the various implications of developments in generative phonology such as markedness, naturalness and abstractness will not be examined in this analysis. The purpose of this section is not to discuss the theoretical values of feature systems as such, but rather to examine the applicability of the various systems to the Australian context in light of both the distribution of phonemes (c.f. 1.0. ff) and the acoustic structures of their phonic realizations (c.f. 2.0. ff).

The feature systems that are discussed in this section are Jakobson-Halle (1956 : 29-32),[74] Chomsky-Halle (1968 : 293-329),

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74. General reference to systems in this section will be by author's name only. The reader is referred to the publications cited here. Naturally, specific reference will be shown.

Ladefoged (1975 : 258-259),[75] Dixon (forthcoming a : 48-53)[76] and Fant (1973 : 25-29).[77] Of these five systems, the first three are designed for universal application, claiming to be able to distinguish all phonemes in any given language. Dixon's system, on the other hand, is devised for Australian languages and makes no claim of universality. Finally, Fant presents us with a system of features which are somewhat different from the other four. His system is concerned with maximally redundant, acoustic characteristics of speech segments; the other systems with minimally redundant phonological classifications. Segmentation is based broadly on the concept that "speech can be divided into a sequence of sound segments the acoustic boundaries of which are definable either from specific articulatory events or from the corresponding time-selective changes in the structural composition of the speech wave". (Fant, 1973 : 25).

The concept of features in phonology is therefore quite different from that of acoustic segments, for we can regard phonology as the classification of phonemes in a "given phonemic system, that is, in the final analysis, with other phonemes it is in opposition". (Trubetzkoy, 1969 : 67). It is sufficient to say for our purposes that the phonological features are concerned with distinctiveness within a system, for features are "determined for a given segment relative to a certain class of segments to which the given segment is assigned". (Chomsky, 1972 : 344).

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75. Also in Ladefoged, 1971 : 92-94.

76. A different representation can be found in his Dyirbal grammar (Dixon, 1972 : 269-382). The more recent system is chosen because of the use of binary representation and is thus more comparable with the binary systems of Jakobson-Halle and Chomsky-Halle.

77. Also found in an earlier publication (Fant, 1968 : 236-241).

The segmental acoustic theory of Fant is therefore excluded from the general discussion on feature types and is examined in a separate section below (see 3.3.0.).

Finally, it will be noticed that a binary distinction is not the only type of opposition in all systems. Ladefoged uses some multi-valued features, whilst Jakobson-Halle and Chomsky-Halle use binary oppositions. Dixon separates privative and equipollent oppositions which are derived from Trubetzkoy (see 3.1.1.4. below). "The issue of whether classificatory features should be binary ... or multivalued ... is not in itself very relevant to a choice between feature systems. Any multivalued feature can be reinterpreted in terms of a number of binary features, and any binary system can be supplied with marking conventions so that it acts as if it contained multivalued features. What is far more relevant to a comparison is the difference in the claims that each system makes both about the phonological relations between sounds and the phonetic facts" (Ladefoged, 1971 : 98).

3.1.0. CONSONANTS

I refer to Table 1 above for a list of consonant phonemes that occur in aboriginal languages.

3.1.1. PLACE OF ARTICULATION FEATURES

In the discussion of feature systems I have used the stop symbol to represent the place of articulation. However, it should be noted that the types of arrangement possible differ for different manners of production. For instance stops (c.f. 1.1.1. ff) and laterals (c.f. 1.1.6. ff) have some dissimilar arrangement types, but nasals correspond predominantly on a one-to-one basis with stops (1.1.5.). We find in aboriginal languages a maximum of eight stop positions of articulation, seven nasal and four lateral. Laterals are non-peripheral and the nasal series naturally lacks a glottal stop equivalent. It is worth noting that the maximal system occurring has only seven stop positions, one with six nasals, the other with seven.

b	d	ḍ	d̪	d^y	g	?	
m	n	ṇ	n̪	n^y	ŋ		e.g. Djabu

b	d	ḍ	d̪	d^y	gj	g	
m	n	ṇ	n̪	n^y	ŋj	ŋ	e.g. Yanyula

3.1.1.1. Jakobson-Halle

	b	d	ḍ	d̪	d^y	g	gj	?
diffuse	+	+	-	+	-	-	-	-
grave	+	-	-	-	-	+	+	-
sharp	-	-	-	+	+	-	+	-
(flat	(-)	-	+	(-)	(-)	(-)	(-)	(-))[78]

Note that /ḍ/ and /d/ are distinct in terms of [diffuse][79] and thus [flat] is redundant. This implies that /ḍ/ differs from /d^y/ only in the feature [sharp], hence Jakobson-Halle make the claim that d/d̪ and ḍ/d^y are more similar in the basic [diffuse] [grave] specifications.

[+sharp] marks palatalization, laminality and palatals, for these sounds "are characterized by an upward shift in some of their upper frequency components" (Jakobson-Halle, 1956 : 31). Peripherals are grouped together by [+grave] and apicals are

78. The use of brackets indicates that the feature itself, or its value for a particular sound, is not necessary for distinctiveness.

79. Specific features will be enclosed in these square brackets throughout this study.

[-grave, -sharp]. Note that /d^y/ and /gj/ differ only in gravity, /d^y/ and /$\underline{d}$/ by diffuseness.

The glottal stop is unmarked by the fact that it has no positive values for position of articulation features; for the glottal stop involves no articulation in the oral cavity. The use of minus values for all features is the most economical representation (see also 3.4.2.2. below).

The feature [flat] would appropriately distinguish the alveolar from the retroflex but in the system this feature is redundant for the distinction is made by [diffuse] alone.

In the types of arrangements found in Australian languages there is naturally a substantial number of redundant features. Disregarding the glottal stop, consider the types of arrangements that were found.

	b	d	d^y	g
grave	+	–	–	+
diffuse	+	+	–	–

(stop type 1.1.1.1.)

	b	d	ḍ	d^y	g
grave	+	–	–	–	+
diffuse	+	+	–	–	–
sharp	–	–	–	+	–

(stop type 1.1.1.2.)

	b	d	$\underline{d}$	d^y	g
grave	+	–	–	–	+
diffuse	+	+	+	–	–
sharp	–	–	+	+	–

(stop type 1.1.1.3.)

	b	d	ḍ	ḏ	d^y	g
grave	+	–	–	–	–	+
diffuse	+	+	–	+	–	–
sharp	–	–	–	+	+	–

(stop type 1.1.1.4.)

The addition of /gj/ to the above system (c.f. stop type 1.1.1.5.) would make no difference to the feature specification as all those necessary for distinctions are present.

The lateral arrangements are set out below. Note that for the single lateral arrangement (c.f. lateral type 1.1.6.1.) position features are non-distinctive; the "unmarked" lateral is the apico-alveolar.

	ℓ	ℓ^y
sharp	–	+
diffuse	+	–

(lateral type 1.1.6.2.) [80]

	ℓ	ḷ	ℓ^y
diffuse	+	–	–
sharp	–	–	+

(lateral type 1.1.6.3.)

	ℓ	ḷ
diffuse	+	–
flat	–	+

(lateral type 1.1.6.4.)

80. Curvy brackets are used here to indicate alternatives.

	ℓ	ḷ	ℓ̪	ℓ^y	(lateral type 1.1.6.5.)
diffuse	+	-	+	-	
sharp	-	-	-	+	

Note that in the lateral type 4 we find the only system where [flat] is a viable feature alternative.

3.1.1.2. Chomsky-Halle

	b	d	ḍ	d̪	d^y	g	gj	?
anterior	+	+	-	+	-	-	-	-
coronal	-	+	+	+	+	-	-	-
distributed	(+)	-	-	+	+	(-)	(-)	(-)
back	(-)	(-)	(-)	(-)	(-)	+	-	-
low[81]	(-)	(-)	(-)	(-)	(-)	-	-	+
high	(-)	(-)	(+)	(-)	(+)	+	+	-

[+distributed] marks the laminals as opposed to the apicals, and [-coronal] marks the peripherals.

In the Jakobson-Halle framework [+sharp] marked palatals, laminals and palatalization. In the present system we have no such feature and resort to the use of [distributed] and [back]. Note the following combination of [high] and [distributed].

	d̪	d^y	gj
distributed	+	+	-
high	-	+	+

81. Chomsky-Halle distinguish the glottal stop by regarding it as a glide (Chomsky-Halle, 1968 : 307) and thus the [low]/[high] features are not really necessary. However the implications of the [high] values

/d̲/ is also distinct from /d^y/ by being [+anterior] and /gj/ from /d^y/ by [-coronal]. Evidence has been suggested for a feature [palatal] (Hyman, 1975 : 243) which can be used instead of [high] in this situation (see also 3.1.2.3.4. and 3.4.1.1. below). The retroflex /ḍ/ for instance, is also [+high] and thus we find the distinction between /ḍ/ and /d^y/ resting in the feature [distributed] as does the distinction been /d̲/ and /d/. Note that /ḍ/ and /d^y/ are [-anterior, +high], /d̲/ and /d/ are [+anterior, -high].

Analysis by stop and lateral arrangements provide the following feature specifications.

	b	d	d^y	g
anterior	+	+	−	−
coronal	−	+	+	−

(stop type 1.1.1.1.)

	b	d	ḍ	d^y	g
anterior	+	+	−	−	−
coronal	−	+	+	+	−
distributed	(+)	(−)	−	+	(−)

(stop type 1.1.1.2.)

	b	d	d̲	d^y	g
anterior	+	+	+	−	−
coronal	−	+	+	+	−
distributed	(+)	−	+	(+)	−

(stop type 1.1.1.3.)

	b	d	ḍ	d̪	d^y	g	(stop type 1.1.1.4.)
anterior	+	+	−	+	−	−	
coronal	−	+	+	+	+	−	
distributed	(+)	−	−	+	+	(−)	

Stop type 1.1.1.5. would involve the use of the feature [back] to distinguish the palato-velar from the velar.

	ℓ	ℓ^y	(lateral type 1.1.6.2.)
distributed	−	+	
anterior	+	−	

	ℓ	ℓ̣	ℓ^y	(lateral type 1.1.6.3.)
anterior	+	−	−	
distributed	−	−	+	

	ℓ	ℓ̣	(lateral type 1.1.6.4.)
anterior	+	−	
high	−	+	

	ℓ	ℓ̣	ℓ̪	ℓ^y	(lateral type 1.1.6.5.)
anterior	+	−	+	−	
distributed	−	−	+	+	

3.1.1.3. Ladefoged

	b	d	ḍ	d̲	d^y	gj	g	?	
glottal stricture	–	–	–	–	–	–	–	+	[82]
place	1	2	3	4	5	6	7		
(grave	+	–	–	–	–	+	+		)
(apical[83]	–	+	+	–	–	–	–		)

One of the more differing characteristics of Ladefoged's system is that the glottal stop is marked by a phonation feature as opposed to an articulatory one. The glottal stop has no inherent articulatory modification in the oral passage and thus cannot be defined in terms of an articulatory place feature. It is worth recalling that the glottal stop has a restricted phonotactic distribution in some Arnhem Lan languages. In Rembarnga and Gunwinggu it has been regarded as a syllable final prosody (c.f. 1.1.2. above); Ladefoged's system is more amenable to this phenomenon by its use of a separate feature specification.

It should be noted that Ladefoged rejects the Chomsky-Halle feature [distributed] on the grounds of its inability to distinguish between an apico-dental and apico-alveolar in Malayalam (Ladefoged, 1971 : 40, 102). We find the feature [apical] used "in order to be able to specify the difference between apical and laminal articulation" (Ladefoged, 1971 : 44). In the feature inventories discussed in this

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82. The feature [glottal stricture] corresponds to the feature [voice] in his later work (Ladefoged, 1975 : 261), where a plus value indicates the glottal stop.

83. The feature [apical] is found only in his earlier work (Ladefoged, 1971 : 93).

section we find all regard laminals as being more marked. Ladefoged's system, by the use of his feature [apical], is both contradistinctive and counterintuitive (see also 2.3.4.).

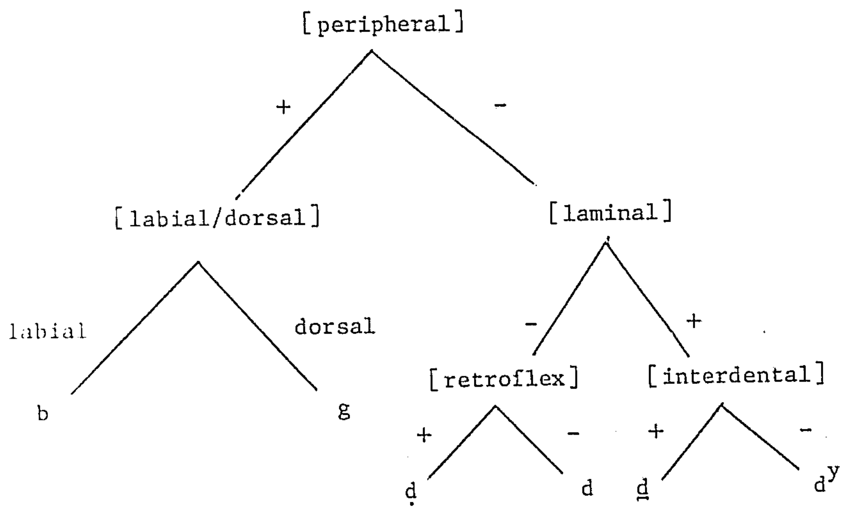
Due to the non-binary aspect of the feature inventory there is little value in listing the types of arrangements found in stops and laterals as was carried out in the other two feature inventories.

3.1.1.4. Dixon

	d	ḍ	d̲	d^y	g	b
peripheral	–	–	–	–	+	+
laminal	–	–	+	+		
retroflex	–	+				
interdental			+	–		
labial/dorsal					dorsal	labial

The most important aspect of Dixon's feature inventory lies in the differing theoretical approach from that found [illegible] the other systems. Ladefoged presents a re-analysis of the Chomsky-Halle system which in turn had its source in the Jakobson-Halle system. Dixon's approach is Trubetzkoian; the use of an equipollent opposition (c.f. Trubetzkoy, 1969 : 75) of [labial/dorsal] is indicative of this aspect. It should be noted that Trubetzkoy and Jakobson were both members of the Prague School of Linguistics (c.f. Ivić, 1965 : 141); Trubetzkoy analysed distinctive oppositions whilst Jakobson developed what we now know as distinctive features. The use of binary features in the Dixon system distinguishes privative oppositions.

It is interesting to note that Dixon's feature specification is hierarchical:



It is immediately apparent that the laminal distinction is regarded as having a greater functional role than [retroflex] or [interdental]. In the Jakobson-Halle system [diffuse] and [sharp] were predominant distinguishing features, whilst in Chomsky-Halle the features were [anterior] and [distributed].

The second aspect as Dixon's analysis of Australian phonology lies in the function attributed to features. A feature system must be a simple account of synchronic phonotactics, must account for morphophonological alternations and diachronic change. They must also have some correspondence with areal distributions and finally, must have phonetic plausibility. (Dixon, pers. comm.). All feature systems attempt to achieve these goals, but in dealing with universal systems the task is inherently more difficult than in a single linguistic area; for Dixon's system is designed for the classification of Australian phonology.

We notice the effect of phonotactic considerations in the use of [peripheral] to distinguish non-peripherals from peripherals. In Mara, for example, the peripheral consonant occurs more frequently than the non-peripheral as the second member of a consonant cluster (Busby, 1978 a : 6). [Peripheral] also distinguishes the [+grave] or

[-coronal] positions of articulation and is thus phonetically plausible. Morphophonological and phonological alternations such as initial apical neutralization (c.f. f.n. 6 above) and the laminal alternation in Tiwi (c.f. 1.1.1.1.) are indicated by the use of [retroflex] and [interdental]. The latter feature also reflects the diachronic development of a double laminal distinction from single laminal. Conversely, the feature distinction of '+' or '-' [interdental] can be shown to be one which has arisen since Proto-Australian. (c.f. Dixon, 1970b). It is worth noting that the use of specific positions of articulation labels such as [retroflex] and [interdental] is no different from Ladefoged's system of articulatory place features.

Areal distribution is reflected by the absence of /gj/ and the glottal stop, and as we will notice later (c.f. 3.1.2.), other more aberrant phonological occurrences. Dixon's system of representation is constructed with the usual Australian pattern in mind (c.f. 1.3.0. above); up to six places of articulation with stops, nasals, laterals, rhotics and glides as the only consonantal manners of articulation. The less frequent, and more aberrant phonemes are excluded.

Historical considerations also suggest that the more aberrant phonemes are the result of later change; for instance the prenasalized stops in Mara (Busby, 1978b) and in some of the northern Paman languages in Cape York (Sutton, 1976 : 102-124). Dixon makes no allowances for these aberrancies which I have classified as Secondary Manner features (see 3.1.2.3. below) on the basis of their uncharacteristic nature and distributional scarcity.

This is indicative of the third and final point to be noted. In Dixon's attempt to consider only the general Australian pattern we find that his features lack universality, a characteristic of the previous three feature systems. In this respect I am reluctant to make comparisons, for this system was developed to explain and describe the phonological structures of Australian languages. It is also of a differing theoretical framework, the merits in relation to other systems is beyond the scope of this non-theoretical analysis.[84] However I do find it somewhat disappointing that the more aberrant phenomena are neglected because they fall outside the domain of the Australian norm.

3.1.2. MANNER OF ARTICULATION FEATURES

In order to compare the four feature systems that have been presented in terms of manner features, it is necessary to distinguish between primary and secondary manners of production. It was noted in the preceeding discussion on Dixon's system (3.1.1.4.) that his analysis is restricted to the usual, common Australian types. We find that the only manners of articulation examined in his system are stops, nasals, laterals, rhotics, glides and vowels. These are the Primary Manners. There is good reason to separate this group for every Australian language, without exception, has one or more phonemes in each of these manner systems (see also 1.3.0. above).

Secondary manners of articulation do not show such distributional characteristics and we find that these are restricted to a small group of languages.

It will be noticed that rhotics and glides are analysed separately (c.f. 3.1.2.2. below). Rhotics have three manners of articulation, the flap, trill and glide. We will notice in the

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84. However, a theoretical discussion of the relative merits of various feature systems with reference to an aboriginal language is Trefry's (1974) description of Diyari.

analysis of glided rhotics and glides that the features distinguishing these two classes will involve positional rather than manner of articulation features.[85] In other words, we find no separate manner features that will distinguish the glided rhotic from the glide. In this respect we will examine glides and rhotics separately, even though the flap and trill are included as liquids and the glides included as glides in the Primary Manner features.

3.1.2.1. Primary Manner Features

It should be noted that all systems can adequately distinguish the major manners of articulation.

3.1.2.1.1. Jakobson-Halle

	stops	nasals	liquids[86]	glides	vowels
consonantal	+	+	+	–	–
vocalic	–	–	+	–	+
nasal	–	+	(–)	(–)	(–)

3.1.2.1.2. Chomsky-Halle

	stops	nasals	liquids	glides	vowels
syllabic	–	–	–	–	+
consonantal	+	+	+	–	–
sonorant	–	+	+	+	+
nasal	–	+	–	(–)	(–)

85. Two feature systems are involved, the Jakobson-Halle and Chomsky-Halle systems (see 3.1.2.2. below).

86. Liquids would include laterals and the flap and trill.

3.1.2.1.3. Ladefoged

	stops	nasals	liquids	glides	vowels
consonantal[87]	+	+	+	-	-
syllabic	-	-	-	-	+
nasal	-	+	-	-	-
stop	+	+	-	-	-
(sonorant	-	+	+	+	+)

[Sonorant] is inherently redundant in this system because of the use of specific manner features. Note also that [syllabic] is regarded more as a prosodic feature (Ladefoged, 1971 : 81) rather than as an intrinsic characteristic of a certain class of sounds as implied in the Chomsky-Halle system. For [+vocalic, -consonantal] in the Jakobson-Halle system is replaced by [+syllabic] in the Chomsky-Halle framework in order to capture the generalization of a CVCV[88] word structure as # [-syll] [+syll] [-syll] [+syll]# (Hyman, 1975 : 43).

3.1.2.1.4. Dixon

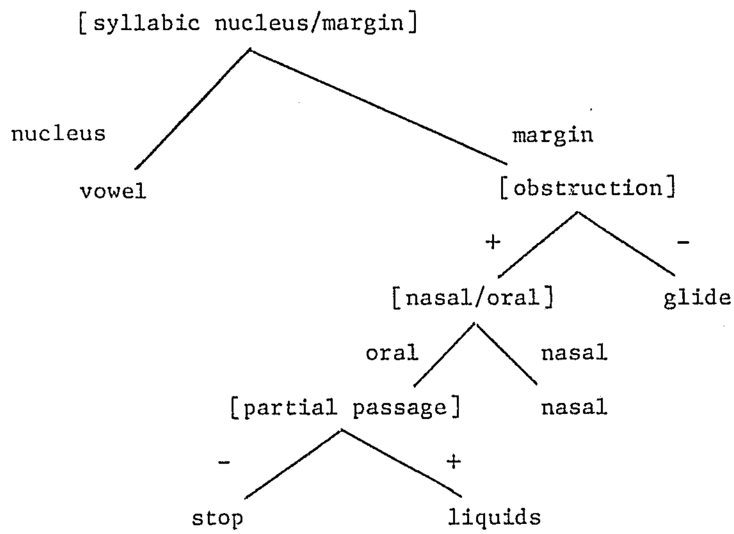
	stop	liquid	nasal	glide	vowel
syllabic nucleus/ margin	margin	margin	margin	margin	nucleus
obstruction	+	+	+	-	
nasal/oral	oral	oral	nasal		
partial passage	-	+			

87. [Consonantal] is found in his earlier work (Ladefoged, 1971 : 92).

88. CVCV stands for consonant-vowel-consonant-vowel, where a consonant is either a true consonant, a liquid or a glide.

The first equipollent feature of [syllabic nucleus/margin] is in terms of phonotactic function rather than a phoneme's intrinsic phonetic nature (Dixon, forthcoming a : 53). However the feature [nasal/oral] could just as readily be a private opposition as it is an equipollent one.

We do find a hierarchy of arrangement in the manners of production as was found in positions of articulation (c.f. 3.1.1.4. above).



3.1.2.2. Rhotics and Glides

In Australian languages we must distinguish between two basic types of rhotic, the flap and trill on one hand, the glided rhotics on the other. The former are liquids and have the same feature specification as those given above. The distinction between the rhotic and the other liquid, the lateral, is specified in the following manners:

Jakobson-Halle : laterals are [-compact], rhotics are [+compact]

Chomsky-Halle : laterals are [+lateral], rhotics are [-lateral]

Ladefoged : laterals are [+lateral], rhotics are [-lateral][89]

Dixon : laterals are [-rhotic], rhotics are [+rhotic]

The Jakobson-Halle system employs a positional feature[90] and is somewhat different from the other three types of representation.

The distinction between the flap and trill is made in the following manners. In the Jakobson-Halle and Chomsky-Halle systems, trills are [+continuant, +strident], flaps are [-continuant, -strident]. Alternatively, trills can be seen as [+tense], flaps as [-tense] as suggested in the analysis of Spanish rhotics (Harris, 1969 : 47) (see also 3.4.2.1. below).

Ladefoged uses the feature [trill] where the trill has a plus value, the flap a minus. Finally, Dixon gives us no indication as to how the distinction between the flap and trill is to be marked.

The glided rhotics can be marked in the same manner as glides, thus [-consonantal] for acoustically they appear to have the same type of formant structure as is found in glides (see 2.4.2. above).

The distinction between all six glides is made in terms of position of articulation features, with no overt marking of rhotics by a manner feature in the following two systems:

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89. In his earlier work, Ladefoged specifies trills and flaps as [+vibration] (Ladefoged, 1971 : 55-56).

90. In some inventories (c.f. Hyman, 1975 : 38) the rhotic is not distinct from the lateral for both are marked as [+diffuse] and hence [-compact]. Fant, however, refers to the rhotic in Swedish as being [+compact] and thus [-diffuse] (Fant, 1973 : 148), reflecting an alveo-palatal place of articulation.

	w	ẅ	y	y̰	R	ɹ
Jakobson-Halle						
consonantal	−	−	−	−	−	−
vocalic	−	−	−	−	−	−
diffuse	−	−	−	+	−	−
compact	−	−	−	(−)	+	+
grave	+	+	−	(−)	−	−
flat	+	−	(−)	(−)	+	−
Chomsky-Halle						
syllabic	−	−	−	−	−	−
consonantal	−	−	−	−	−	−
coronal	−	−	−	−	+	+
high	+	+	+	−	+	−
back	+	+	−	(−)	(−)	(−)
round	+	−	(−)	(−)	(−)	(−)

The first system uses [compact] to distinguish the glided rhotic from the glides, the second uses [coronal]. Note that in the Chomsky-Halle system glides have always been considered as having minus values for [anterior] and [coronal]. However, retroflexed vowels are considered [+coronal] (Chomsky-Halle, 1968 : 304) and I see no reason not to apply the same principle to both rhotics and make this system more similar to Jakobson-Halle's analysis.

Both Dixon and Ladefoged have specific rhotic specification features [+rhotic] and [+vibration][91] respectively. We can assume that glided rhotics are also distinguished in terms of positions of articulation. Articulatory place features present no problem because both systems use specific points of articulation as their features, rather than a combination of features reflecting the characteristic of such a position as is the case in both the Chomsky-Halle and Jakobson-Halle systems. Note, however, that Dixon's system would not automatically distinguish the two glides /ẅ/ and /y̑/ or the rhotic /ɹ/ as their occurrence is limited to only a few languages.

Finally it is worth noting that only one system has a specific feature that distinguishes rhotics from all sounds irrespective of whether they are liquids or glides. Dixon's [rhotic] is this feature and it is worth noting that its alternatives in the Ladefoged system, [vibrant] or [rhotacized] (c.f. f.n. 91) is not as suitable. This reflects that the universal aspect inherent in Ladefoged's system does not work as well as the areally specific system of Dixon's.

3.1.2.3. Secondary Manner Features

As was prevously mentioned, secondary manner features are those which are not an integral part of Dixon's system, those phonemes which are atypical of Australian phonology. It must be remembered that a certain number of articulatory manners examined below are dependant on phonotactic considerations in particular phonological analyses. These do not necessarily have any phonetic

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91. It is somewhat debatable whether [vibration] would apply to glided rhotics as its original specification was for the distinction of trills and flaps from other liquids (c.f. f.n. 89 above). His feature [rhotacized] may be considered suitable (note however, the comments in 3.1.2.3.5. below).

difference from sounds not treated as units in other analyses and thus already specified. For example, prepalatals may be considered as clusters of the palatal glide plus the appropriate consonant (see 3.1.2.3.4. below). On the other hand, labialization can be adequately described by the addition of certain features (c.f. 3.1.2.3.6. below).

3.1.2.3.1. Second Series Stops

The researchers who have analysed these languages with two series of stops give various specifications as to its intrinsic nature (see 1.1.3. above). A recapitulation of the specifications given is set out below and we see that these can be easily distinguished in the different feature systems.

geminate/non-geminate

fortis/lenis

voiced/voiceless

aspirate/non-aspirate

tense/lax

Gemination in the Jakobson-Halle framework is notated by the use of [+tense] (Hyman, 1975 : 41). Chomsky-Halle notation involves the segmentation of the phonemes into two consecutive segments, both with the same feature specification. Ladefoged employs the feature [rate] (Ladefoged, 1971 : 93).

A fortis/lenis distinction is marked in the same manner as a tense/lax opposition in both the Jakobson-Halle and Chomsky-Halle systems. Both use the feature [tense]. It should be noted that the feature [tense] in the Jakobson-Halle framework marks all second stop series distinctions except voicing. This implies that the perceived language specific differences do not result in different analysis in the Jakobson-Halle system. (See also 3.4.2.2. below).

On the same note, we are not forced to be specific as to the phonemic nature of the distinction which is required for the Chomsky-Halle and Ladefoged analyses. The Ladefoged specification separates these two manners of stop distinction; [tension] for a tense/lax distinction and [fortis] for the fortis/lenis (Ladefoged, 1971 : 92-93).

Voicing is marked in the same manner in the Chomsky-Halle and Jakobson-Halle systems by the use of the feature [voice]. Ladefoged, on the other hand, employs the feature [voice onset], the same feature distinguishing an aspirate/non-aspirate opposition.[92] Chomsky-Halle have the feature [heightened subglottal pressure] for this opposition, Jakobson-Halle use the feature [tense].

3.1.2.3.2. Prenasalization

Chomsky-Halle present us with two suggestions as to the treatment of prenasalized stops. McCawley is reported to have specified prenasalized stops as [+consonantal, -sonorant, +nasal] (Chomsky-Halle, 1968 : 317). However, such a specification marks the prenasalized stop as a nasalized stop or a non-sonorant nasal. Also, it is not indicative of the fact that the prenasalized stop has a nasal segment followed by a stop.

The second suggestion involves the use of the [delayed release] feature. It is claimed that "the difference between prenasalized and ordinary nasal consonants might be regarded as an instance of instantaneous versus delayed release. This suggestion appeals to us but we are at present unable to provide serious arguments in its favour" (Chomsky-Halle, 1968 : 317). However, we must reject this suggestion for the release of the prenasalized stop is the same as

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92. In his later work voicing is listed under two features, [voice] and [aspiration] (Ladefoged, 1975 : 258). In this later framework the latter feature would mark an aspirate/non-aspirate distinction.

for a normal stop. It is the case that the velum is raised before the release of the stop, followed by the onset of the vowel.

Velaric opening can be seen as a similar event to that of voice onset. Ladefoged recognizes this factor and includes the feature [prenasality] to distinguish this group of sounds (Ladefoged, 1971 : 92).

Jakobson-Halle make no specific allowances for prenasalized stops and we would revert to the use of sequences of homoganic nasals and stops, a solution that we may wish to avoid (c.f. 1.1.0. and 1.1.4. above).

3.1.2.3.3. Prestopping

The Chomsky-Halle and Ladefoged systems are capable of distinguishing the prestopped nasals and laterals. The former uses the [delayed release] feature with a nasal or lateral manner. Ladefoged's feature [voice onset] can be modified to allow for nasal onset and lateral onset.

It must be recalled however, that a prestopped nasal functions phonotactically in Arandic languages in the same manner and is sometimes phonetically realized as a long, tense nasal[93] (c.f. 1.1.7.). Therefore to specify release factors in the feature description is contrary to the actual nature of these phonemes.

3.1.2.3.4. Prepalatalization

Feature descriptions such as those described in the two parts immediately preceeding will fail in the same manner for

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93. Note that gemination is marked in the Chomsky-Halle system as two consecutive segments (3.1.2.3.1. above) and is thus suggestive of an alternative to the analysis presented here. However, Chomsky-Halle use [delayed release] specifically for the lateral release of stops (Chomsky-Halle, 1968 : 319).

prepalatalized stops, nasals, prestopped nasals and laterals. Since prepalatalization is a morphophonemic device in order to develop a two vowel system in Andegeribina (see also 1.1.8. above) it could perhaps best be regarded as a prosodic feature. One method would be to use a feature [palatal]. Note that we can incorporate this feature into the Chomsky-Halle system of positions of articulation. It was noted earlier (3.1.1.2.) that the palatal and palato-velar positions have no specific feature specifications that distinguish them from other sounds. Instead of relying on the features [back] and [high], the feature [palatal] would be more applicable. Consider the arrangement, noting that the retroflex is also [+high].

	d̲	ḍ	d^y	gj	g
high	–	+	+	+	+
back	–	–	–	–	+
distributed	+	–	+	–	–
coronal	+	+	+	–	–

The use of the feature [palatal], in combination with [distributed] can show a phonetically more ac .urate and phonologically simpler arrangement.

	d̲	ḍ	d^y	gj	g
distributed	+	–	+	–	–
palatal	–	–	+	+	–
coronal	+	+	+	–	–

3.1.2.3.5. Rhotic Release

The use of Chomsky-Halle's release feature [delayed release] can adequately describe the rhotic release. However, we must specify the nature of this release and two systems, Dixon and Ladefoged offer suggestions. Dixon's feature [rhotic] could be easily applied, but Ladefoged presents us with two possible alternatives, [rhotacized] or [vibration]. The former is used mainly in vowel specifications (Ladefoged, 1975 : 266) and the latter is apparently restricted to trills and flaps (c.f. f.n. 91 above). In 3.1.2.2. we noticed the value of a general feature [rhotic] which is not restricted to either liquids or glides; this feature can also be employed for the rhotic released stop (see also 3.4.2.2.).

3.1.2.3.6. Labialization

The phenomenon of labialized or rounded consonants is readily integrated into the feature systems. Ladefoged and Chomsky-Halle employ the feature [round]. Jakobson-Halle use the feature [flat]. Note that in this latter system, the distinction between [ḍ], [ḍ^{W}] and [d^{W}] cannot be made on the basis of [flat] alone as the retroflex is already considered the [+flat] counterpart of the alveolar. (c.f. 3.1.1.1. above). Labialization, it should be noted, may be considered a prosody and thus not attached to a specific segment, the same being a possibility for prepalatalization.

3.1.2.3.7. Fricatives

Fricatives are a rare occurrence in Australian languages (c.f. 1.1.13. above), their positions of articulation readily incorporated into the already existing frameworks. The fricatives recorded are /s, z, ð, ʒ, β, γ/. The manner of production specification in the Chomsky-Halle and Jakobson-Halle systems is by the use of the feature [continuant], where a fricative has a plus value. Note however, that these two systems have differing implications. Nasals and stops in the Chomsky-Halle system are [-continuant], fricatives [+continuant]. In the Jakobson-Halle framework, nasals and fricatives are [+continuant], stops are [-continuant]. In other words, in terms of the distribution of [continuant] in the Chomsky-Halle system nasals and stops form one class, whilst in the latter system the nasals and fricatives form the same class. Finally, Ladefoged uses a specific feature [fricative].

3.2.0. VOWELS

The manner of production features that distinguish vowels from other sounds are given in 3.1.2.1. above. Twelve vowels have been recorded in aboriginal languages (c.f. Table 3 above) but the maximal system is found in Wik-Ep with a possible nine vowel system /i, e, a, o, u, ü, ö, (ʉ), (ɨ)/.[94] Ladefoged presents us with the only system capable of distinguishing all twelve vowel positions.

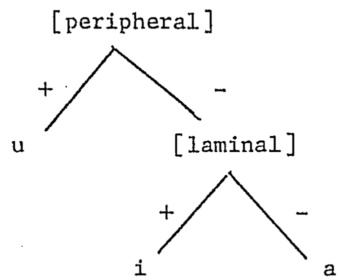
	i	ü	e	ö	æ	ɨ	ʉ	ə	a	ɔ	o	u
aperture	1	1	2	2	3	1	1	2	4	3	2	1
position	1	1	1	1	1	2	2	2	2	3	3	3
round	-	+	-	+	(-)	-	+	(-)	(-)	+	+	+

[1 aperture]	=	high	[1 position]	=	front
[2 aperture]	=	mid-high	[2 position]	=	central
[3 aperture]	=	mid-low	[3 position]	=	back
[4 aperture]	=	low			

94. These vowels also have a length distinction (Hale, 1960).

Note that /a/ is considered a central vowel and not back; both Chomsky-Halle and Jakobson-Halle usually specify this vowel as [+back]. It is worth noting that the distinction of the three central vowels /ɨ/, /ʉ/ and /ə/ can only be accomplished by the use of [-syllabic] (Chomsky-Halle, 1968 : 176) or [-tense] (c.f. Ladefoged, 1971 : 77-79) in the Chomsky-Halle system; the features [-vocalic, -tense] would apply in the Jakobson-Halle system.

In Dixon's feature system only the common three vowel system of /i, a, u/ is examined, the arrangement is again hierarchical.



We notice that the same features are used to distinguish vowels and consonants, a phenomenon shared with the Jakobson-Halle system.

It is noticeable that the vowel /a/ is unmarked in this system, just as the alveolar position of articulation is (c.f. 3.1.1.4. and f.n. 67 above) for "they are <u>not</u> specified for the positive features '+peripheral' or '+laminal' " (Dixon, forthcoming a : 52). It is interesting to note that the only unmarked consonant in any other feature system is the glottal stop in the Jakobson-Halle framework. In the Chomsky-Halle and Jakobson-Halle systems the unmarked vowel is /e/. "Recall that in the neutral position the body of the tongue was assumed to be raised and fronted, approximating the configuration found in the vowel [e] in English <u>bed</u>". (Chomsky-Halle, 1968 : 304). Ladefoged's representation allows for no such neutrality for he remarks that he knows of "no evidence that this position is the level of that in the vowel [e]" (Ladefoged, 1971 : 99); in fact no universal neutral position as such.

Listed below are some methods by which the major vowel arrangements may be distinguished in the binary systems of Jakobson-Halle and Chomsky-Halle.

	i	a	u	(vowel type 1.2.1.1.)
Jakobson-Halle				
diffuse	+	−	+	
grave	−	+	+	
Chomsky-Halle				
high	+	−	+	
back	−	+	+	

	i	e	a	u	(vowel type 1.2.1.2.)
Jakobson-Halle					
diffuse	+	−	−	+	
grave	−	−	+	+	
Chomsky-Halle					
high	+	−	−	+	
back	−	−	+	+	

	i	e	a	o	u
Jakobson-Halle					
grave	−	−	+	+	+
diffuse	+	−	−	−	+
flat	−	−	−	+	+
Chomsky-Halle					
high	+	−	−	−	+
low	−	−	+	−	−
back	−	−	+	+	+

(vowel type 1.2.1.3.)

3.2.1. DIPHTHONGS

In Australian languages we find both onglide and offglide diphthongs (c.f. 1.1.2. above). In Kuthant and Kurtjar we recorded two cases of the former /ia(:)/ and /ɨa(:)/. Note that the occurrence of vowel length only on the second member is indicative of the onglided nature of these two diphthongs. Three offglide diphthongs /ua/, /ui/ and /ai/ are found in Umbuygamu and Gudandji. It has been the general practice to regard the glided segment of a diphthong as a glide and thus the feature specification would be the same as that given for glides above (3.1.2.1. ff.).

3.2.2. NASALIZED VOWELS

Nasalized vowels are phonologically contrastive only in Mpakwithi and would be marked by [+nasal] in all three systems. Dixon's analysis would not include this phonological aberrancy.

3.3.0. FANT FEATURES[95]

It has already been noted in the introduction to this section (3.0. above) that Fant's system is concerned with the acoustic differences between segments. Thus notions of distinctiveness and redundancy are relatively unimportant. "When sound segments are decomposed into bundles of simultaneous sound segments it is often seen that a single sound feature carrying a minimal distinction may extend over all sound segments of importance for a phoneme, including sound segments which essentially belong to adjacent phonemes" (Fant, 1973 : 25-26).

The sound features that make the minimal distinctions in the phonology of Australian languages are outlined below. The number indicates the "Segment Pattern Feature" (Fant, 1973 : 28).

/b/ 16. Bilabial closure.

/d̪/ 17. Interdental articulation.

/d/ 18. Dental or prealveolar articulation.

/ḍ/ 15. Retroflex modification.

/dʸ/ 19. Palatal articulation with tip of tongue down.

/g/ 20. Velar and pharyngeal articulation.

/gj/ 20. as above plus 11. Tongue frontal (a) mid palatal position.[96]

/?/ 21. Glottal source.

Manners of articulation are distinguished by "Speech Production Correlates" (Fant, 1973 : 27-28).

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95. The features are found in two sources; Fant 1973 : 25-29 and 1968 : 236-241; I have used the former.

96. We could add another feature: 20(a) Front velar and 20(b) Back velar.

Stops	4.	Occlusive.
Nasals	7.	Nasal.
Laterals	6.	Lateral
Vowels	8.	Vowel-like
Glides	10.	Glide.
Flap	9.	Transitional plus 4. Occlusive.
Trill	9.	Transitional plus 4. Occlusive plus 9. Transitional plus 4. Occlusive ...[97]
/R/	10.	Glide plus retroflex (= 15. Pattern feature).
/ɹ/	10.	Glide minus retroflex.
Fricatives	5.	Fricative.

The other secondary manner features would be combinations of release and transition features, characteristic of each particular segment.

It should be noted that this list of segment features is not exhaustive. Stops can also be described in terms of [silence] and [transient], for there is both a period of silence, with or without voicing, before the release and an effect on vowel formant transitions, the transient component (see also 2.3.3. for the acoustic study of vowel transitions).

It is sufficient to say that Fant's system of analysis concerns itself with the description of segment types present in differing sequences of sounds. This is a somewhat different aim from that found in distinctive feature systems for Fant's segmental studies have an engineering orientation. (Fant, 1973 : 23). To compare the two

97. A trill is characterized by a series of silent periods in rapid progression (see 2.4.1. above), hence the use of repeated segment specifications.

approaches is therefore a futile exercise for the notion of phonological distinctiveness is somewhat foreign to Fant's analysis. This is not to say that Fant's analysis has no value, for he provides a series of "features" or segment types characteristic of segments, its usefulness is more in terms of acoustic analysis rather than distinctive features.

3.4.0. A FEATURE INVENTORY FOR AUSTRALIAN LANGUAGES

In the preceeding section we have discussed the ability of the feature systems to adequately describe Australian phonology. Little value is derived from comparative judgements on the relative merits of each feature system, for it would be more profitable to construct a feature inventory incorporating the analysis of the above sections. Two important points should be noted before we describe the Australian situation.

The first concerns my view of the nature of the proposed feature system. The approach adopted has been to present "an inventory of phonetic correlates" (Fant, 1973 : 172). These correlates may be either acoustic or articulatory, for "although we could (with difficulty) characterize all possible systematic phonetic contrasts entirely in physiological terms, it would be ridiculous to overlook the fact that some phonological rules obviously work in terms of acoustic properties of sounds" (Ladefoged, 1971 : 4).

Secondly, it should be noted that the feature systems of the types discussed above exemplify a method of distinguishing phonemes, as the use of the term "distinctive features" implies. Ladefoged's system, however, is a classification of the sounds, not necessarily phonemic, of a language. The system proposed here is orientated towards this descriptive aspect of feature systems, with the emphasis on phonetic accuracy rather than economy.

3.4.1. POSITION OF ARTICULATION FEATURES

In the inventories of positions of articulation we notice that the consonants and vowels are not distinguished by the same features. Consonant features are both acoustic and articulatory in definition, whilst vowel features are articulatorally labelled with measurable acoustic correlates. The articulations of consonants and vowels are inherently different; vowel production is in terms of tongue body positions. Consonantal[98] sounds involve an active and passive articulator. "..human perception of a vowel probably operates with a direct identification of its approximate place in a multi-dimensional continuous parameter space" (Fant, 1973 : 200-201). Note that glides are distinguished by consonant features (3.4.2.) even though there is no passive articulator. This differs from the Chomsky-Halle arrangement which uses vowel articulation features to distinguish both glides and vowels (c.f. 3.1.2.2. above). Finally, the glottal stop is distinguished by the lack of position of articulation features (see 3.4.2.2. below).

3.4.1.1. CONSONANTS

	b	d	ḍ	d̲	d^y	gj	g [99]
grave	+	–	–	–	–	+	+
diffuse	+	+	–	+	–	–	–
laminal	–	–	–	+	+	–	–
palatal	(–)	(–)	(–)	–	+	+	–

98. Note that glides and the glottal stop are regarded as [-consonantal].

99. The use of the stop symbols again indicates the position of articulation; the same method is employed throughout this section.

We notice that the feature [flat] is redundant, for the retroflex/alveolar distinction is made on the values of [diffuse]. /ḍ/ is the [-diffuse] counterpart to /d/ in that there is a greater descent of adjacent F_3 values in retroflexes than in alveolars (c.f. 2.9.0.), thus the retroflex is more compact and hence [-diffuse]. We may have wished to regard /gj/ as the non-flat counterpart of /g/, as is the case of a velar/uvula distinction, thus making the feature [palatal] redundant. However, this would imply that the velar is more marked than the palato-velar; a claim unsupported by the distribution of these phonemes in languages (c.f. 1.1.1.5. and 2.3.4.1.).

Gravity is the "concentration of energy in the lower (vs. upper) frequencies of the spectrum" (Jakobson-Halle, 1956 : 31) and corresponds with the articulatory group peripheral (2.8.1.). [Coronal] is rejected for it is a definition of the passive place of articulation by a movement of the active articulator. "Coronal sounds are produced with the blade of the tongue raised from its neutral position" (Chomsky-Halle, 1968 : 304). We also fail to find an acoustic definition even though it does correspond to [grave] in its distribution but with opposite values. Finally [coronal] specifications are normally restricted to [+consonantal] phonemes and thus excluded from glides, a situation we will avoid (note however, 3.1.2.2. and 3.4.1.).

[Diffuse] is defined as "a higher (vs. lower) concentration of energy in a relatively narrow region of the spectrum, accompanied by an increase (vs. decrease) of the total amount of energy" (Jakobson-Halle, 1956 : 29). [Anterior] corresponds roughly to the [diffuse] feature and can be taken as the articulatory counterpart. "Anterior sounds are produced with an obstruction that is located in front of the alveo-palatal region of the mouth" (Chomsky-Halle, 1968 : 304).

The feature [palatal] is usually correlated with the acoustic feature [sharp] in the Jakobson-Halle system (c.f. 3.1.1.1. above). Palatal sounds are produced in the palatal region, acoustically characterized by higher "frequency components" (Jakobson-Halle, 1956 : 31) than that found in non-palatal segments (see also 2.3.4.).

[Laminal] sounds are those produced with the blade of the tongue (c.f. 2.8.2.) characterized by high frequency energy (c.f. 2.3.4.). This corresponds to Dixon's feature [laminal], but not to the Chomsky-Halle feature [distributed]. This latter feature is a statement of a constriction "that extends for a considerable distance along the direction of the air flow" (Chomsky-Halle, 1968 : 312); thus /b/ is [+distributed] (c.f. 3.1.1.2. above). It does not, therefore, necessarily say anything about the activity of the tongue blade.

3.4.1.2. VOWELS

The multi-valued features employed for the description of vowel phonemes follow the specifications given by Ladefoged. (See also 3.2.0.). Vowel articulation involves the body of the tongue, the characteristics of which can be distinguished by the following features. [Height] is "the inverse of the frequency of the first formant"; [back] is "the degree to which the tongue approaches the soft palate or the back wall of the pharynx" and [round] is the "position of the lips" (Ladefoged, 1971 : 75).

The acoustic correlates are suggested in an $F_2' \times F_1$[100] representation (Ladefoged, 1971 : 73-75). Unfortunately, our F_3 data for vowels is somewhat scarce because energy is predominantly concentrated in the lower frequency ranges; hence even spectrograms

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100. $F_2' = F_2 + \frac{1}{2}(F_3-F_2) \dfrac{(F_2-F_1)}{(F_3-F_1)}$ (Fant, 1973 : 52).

using a High Pass-filtered source often didn't show the third formant. We do find, however, that the F_2xF_1 representations are indicative of the same correlations (2.7.1. and Appendix 7).

	i	ü	e	ö	æ	ɨ	ʉ	ə	a	ɔ	o	u
height	1	1	2	2	3	1	1	2	4	3	2	1
back	1	1	1	1	1	2	2	2	2	3	3	3
round	−	+	−	+	−	−	+	−	−	+	+	+

Nasalized vowels and diphthongs are adequately described above (3.2.1. and 3.2.2.); length can be shown by the feature [tense] or [long] (see also 3.4.2.2. below for geminate consonants).

3.4.2. MANNER OF ARTICULATION FEATURES

We have previously mentioned that the glottal stop is a somewhat different position of articulation in that it involves no articulatory modification in the mouth (c.f. 2.3.3.4. and 3.1.1.2.). It also involves different manner features than those given for stops as will be noted in secondary manner features below (3.4.2.2.).

3.4.2.1. Primary Manner Features

	stops	nasals	laterals	trills & flaps	glided rhotics	glides	vowels
syllabic	−	−	−	−	−	−	+
consonantal	+	+	+	+	−	−	−
sonorant	−	+	+	+	+	+	+
rhotic	(−)	−	−	+	+	−	(−)
nasal	(−)	+	−	(−)	(−)	(−)	(−)
lateral	(−)	−	+	(−)	(−)	(−)	(−)

Glides and glided rhotics are distinguished by the feature [rhotic], the same feature that distinguishes the liquids. Note that nasals, laterals and trills/flaps are distinguished in terms of two combinations of features, either [rhotic] and [lateral], or [rhotic] and [nasal].

[Syllabic] corresponds in this system to both the Chomsky-Halle (1968 : 354) and Ladefoged specifications, although the latter author is reluctant to define it. "We will therefore assume that a neurophysiological definition is possible, even if we cannot at the moment state it in any way" (Ladefoged, 1971 : 81).

"Consonantal sounds are produced with a radical obstruction in the mid-sagittal region of the local tract" (Chomsky-Halle, 1968 : 302). Sonorant phonemes are "those sounds with an auditory property which arises from their having a comparatively large amount of acoustic energy within a clearly defined formant structure" (Ladefoged, 1971 : 58). This can be contrasted with Chomsky-Halle's rather inadequate physiological definition: "sonorants are sounds produced with a vocal tract configuration in which spontaneous voicing is possible" (Chomsky-Halle, 1968 : 302).

[Rhotic] is taken in the manner specified in Dixon's system (c.f. 3.1.2.2.) and like [nasal] and [lateral], is self-explanatory.

Finally, the problems that beset the Jakobson-Halle and Chomsky-Halle systems in the distinctions of rhotics and glides (c.f. 3.1.2.2. above) present no problems here.

	ℓ	r	ř	R	ɹ	w	ẅ	y̰	y
consonantal	+	+	+	–	–	–	–	–	–
rhotic	–	+	+	+	+	–	–	–	–
grave	–	–	–	–	–	+	+	–	–
diffuse	+	+	+	–	+	–	–	+	–
round	(–)	(–)	(–)	(–)	(–)	+	–	(–)	(–)
tense	(–)	–	+	(–)	(–)	(–)	(–)	(–)	(–)

[Tense] is used to distinguish the flap and the trill, the former takes the minus value (c.f. Harris, 1969 : 43). [Round] is used to distinguish the unrounded from rounded /w/. This feature is preferred to Jakobson-Halle's [flat] so that we have consistency in rounding of vowels, glides and in the labialization of consonants (see 3.4.2.2. below).

3.4.2.2. Secondary Manner Features

The secondary manners of production that are an incorporation of phonotactic considerations have been discussed at length in the feature discussions above (3.1.2.3. ff.). The following comments serve as guidelines as to how these secondary manners may be incorporated. We should note, however, that their description is perhaps best left to specific language analysis rather than to incomplete attempts here, thus the feature specifications are only suggestive.

[Tense]

This feature that distinguishes the flap from the trill and the long vowels can also be satisfactorily used for the distinction of the second series stops. We note that of all five specifications of distinction: geminate, fortis, voiceless, aspirate and tense; none are contrastive with each other within a language. In order to be economical we can use the Jakobson-Halle feature [tense] to distinguish this opposition. Note that Wood, for instance, specifies the stinction in Galpu as "fortis, voiceless and geminate" (Wood, 1977 : 28); the same phenomenon apparently occuring in most Arnhem Land languages (Merlan, pers. comm.).

Glottal Stop

We exlcuded the glottal stop from positions of articulation because it has no articulatory modification in the mouth. We can also exclude it from the primary manners of articulation because of its restricted distribution in Australian languages (c.f. 1.1.2. above). I follow the Jakobson-Halle specification of the glottal stop and assign a minus value to all features. This differs somewh - from the Chomsky-Halle system where the glottal stop is regarded as a glide, hence [+sonorant]. By the use of minus values for all features we are economical in our description, although it could be seen as being at the expense of phonetic accuracy, as implied in the Ladefoged feature [glottal stricture] (c.f. 3.1.1.1. and 3.1.1.3.).

[Prenasal]

"This feature, like the voice onset feature ... must be defined in terms of the duration of the event. It is the duration of the velopharyngeal opening which occurs before another articulation such as an oral stop or fricative in circumstances which require the whole complex to be considered as one phonological unit" (Ladefoged, 1971 :35). We can thus distinguish stops from prenasalized stops by the addition of this feature to the inventory of a stop.

[Prestop]

This feature, attached to the specification of nasals and laterals mark prestopped nasals and laterals respectively. This implies that the prestopped nasal and lateral are classified as a modification of a nasal and lateral. This is in agreement with their occasional phonetic realizations as long nasals and laterals, as well as their phonotactic function (see 1.1.7. above).

[Prepalatal]

In Andegeribina we find the prepalatals /^{y}d, ^{y}n, ^{y}N, $^{y}\ell$/. (Breen, 1977). Considering that the prepalatal is a construction to allow for a morphophonemic two vowel system it may be best to regard this feature as a prosody. However, we notice that its occurrence is only with certain alveolars and thus these phonemes should carry the [prepalatal] feature in their inventory at the morphophonemic level.

[Delayed rhotic release]

The use of the Chomsky-Halle feature [delayed release], coupled with our feature [rhotic], is indicative of the type of process involved with rhotic released stops and prenasalized stops (see also 3.1.2.3.5.).

[Round]

The distinction between rounded and unrounded glides and vowels is made by this feature (c.f. 3.4.1.2. and 3.4.2.) and is applicable in the description of all labialized consonants.

[Continuant]

Even though [continuant] applies to many manners of articulation, this feature is used to distinguish stops from fricatives, the former marked as [-continuant]. Note that the Jakobson-Halle's use of the feature with nasals (3.1.2.3.7. above) applies in our feature inventory where nasals are [+continuant]. This is contrasted with Chomsky-Halle's specification of [-continuant] for nasals. Finally, the glottal stop is considered in our system as [-continuant].

CONCLUSION

The structure of phonemic systems in aboriginal languages is generally uniform and limited to a small number of arrangement types. In stops and nasals we find a one-to-one correspondence, with four major types of arrangements:

(1.1.1.1.) b d d^y g

(1.1.1.2.) b d ḍ d^y g

(1.1.1.3.) b d d̪ d^y g

(1.1.1.4.) b d ḍ d̪ d^y g

The fifth type, involving the addition of the palato-velar to type 4 above is rare and restricted to four languages (1.1.1.5.).

We do find, however, some cases of non-uniform correspondence between nasals and stops and it is the palatal nasal in the single laminal stop languages and the dental nasal in the double laminal languages that is either subphonemic or not present. The palato-velar nasal was absent in two of the languages that recorded the corresponding stop.

Lateral distributions do not necessarily follow the same patterns of stops and nasals, for there is not a regular one-to-one correspondence of lateral positions to non-peripheral stops and nasals. We recorded that most languages have one of the following lateral systems.

(1.1.6.1.) ℓ

(1.1.6.3.) ℓ ℓ̣ ℓ^y

(1.1.6.4.) ℓ ℓ̣

(1.1.6.5.) ℓ ℓ̣ ℓ̪ ℓ^y

We noticed that the lateral arrangement /ℓ ℓ^y/ (1.1.6.2) occurred in only nine cases in our data.

All languages had rhotics in their phonological systems, the majority having two, /R/ and /r/ (1.1.11.1.); the retroflex glided rhotic and the flap alternating with the trill. Rhotic systems where the trill and flap are both phonemic are also found; so too was the single rhotic /r/. This latter system is found along the east coast of the continent and in Cape York.

With the exception of five languages, only two glides are recorded in Australian languages, /w/ and /y/. Those languages with three glides have either the unrounded /ẅ/ or the dental /y̪/ (1.1.12.).

The above descriptions serve as a general statement of most of the phonological systems of consonants in Australian languages; the more aberrant phonological forms are limited to a small number of languages. For instance, the glottal stop is found in languages located in Arnhem Land and Cape York; the prestopped nasals and laterals in Central Australia, with one instance of prestopped nasals in Cape York, Kunjen. The second series of stops on the other hand is more widely dispersed although Arnhem Land languages account for a large number. Fricatives are found predominantly in Cape York although the Daly River region, Central Australia and Thargari in Western Australia, are outside this main region.

The eastern Northern Territory-South Australian north-south border is an important areal feature for the distribution of the stop system /b d ḍ d^y g/ and the lateral type /ℓ ḷ $ℓ^y$/. The east coast and Cape York are also significant for the occurrences of the single rhotic /r/, the single lateral /ℓ/ and the stop systems /b d d^y g/ and /b d d̪ d^y g/.

Cape York has a major concentration of aberrant vowel systems where we find many systems restricted to a single language. Vowel systems, like consonants, have a more frequently occurring system; /i a u/ is the most common although the inclusion of other vowels such as /e/, /ə/ and /o/ is not so uncommon. Vowel length is found in about half the languages and has no areal congruence. Two morphophonemic vowel systems are recorded, Andegeribina /a a:/ and Kaititj /a ə/.

In the acoustic study in some characteristics of the phonetic realizations of these phonemes of nineteen selected languages we find justification for two major distinctions. The first is the function of relative F_2 values; the low-F_2 class contains the peripherals [b], [g] and [gj]; the mid-F_2 class contains the two apicals and the dental, [d], [ḍ] and [d̲]; and the high-F_2 class the palatal [d^y]. Note that these relative classes are not restricted to stops alone, the same grouping applies to both nasals and laterals.

The second distinction found in our acoustic analysis is the division of non-peripheral positions of articulation into apicals and laminals; a division that is common in Australian language descriptions and runs throughout this thesis. We found that the active articulator, the blade of the tongue in laminals, the tip in apicals, is a necessary distinction for the classification of the mid-F_2 class. Laminality has the acoustic characteristic of high frequency energy (2.8.2.) and the apical retroflex has plunging F_3 values in surrounding segments (2.3.4.). We note that the apico-aveolar is not marked in any specific manner for the active articulator distinctions.

In the description of the acoustic structure of vowel segments we notice that vowel length differences are also manifested in some cases by aperture differences. Phonetic overlap of the 95% confidence limits is not uncommon in vowels; nor is it in nasals and laterals for instance. The distinctive feature system of vowels (3.4.1.2.) classified vowels in terms of aperture relations which differs from the consonant distinctions in terms of cavity features and active articulator correlates.

We notice that in the distinctive feature specification (3.4.0. ff.), three features are necessary for an accurate description of Australian phonology; [laminal], [palatal] and [rhotic]. It should be noted that two of these derive from the Dixon feature system, [laminal] and [rhotic], which is a classification of phonemes of the typical Australian type. His feature system also serves as the basis for the primary and secondary manners of articulation division (c.f. 3.1.2.).

The development of the feature description of aboriginal languages was the result of an examination of the ability of other feature systems to describe Australian phonological systems. The classificatory ability of a feature system to distinguish the phonological distributions focus not only on the distinctive aspects but also on the implications of such an analysis: whether a system is characteristic of the Australian situation or not.

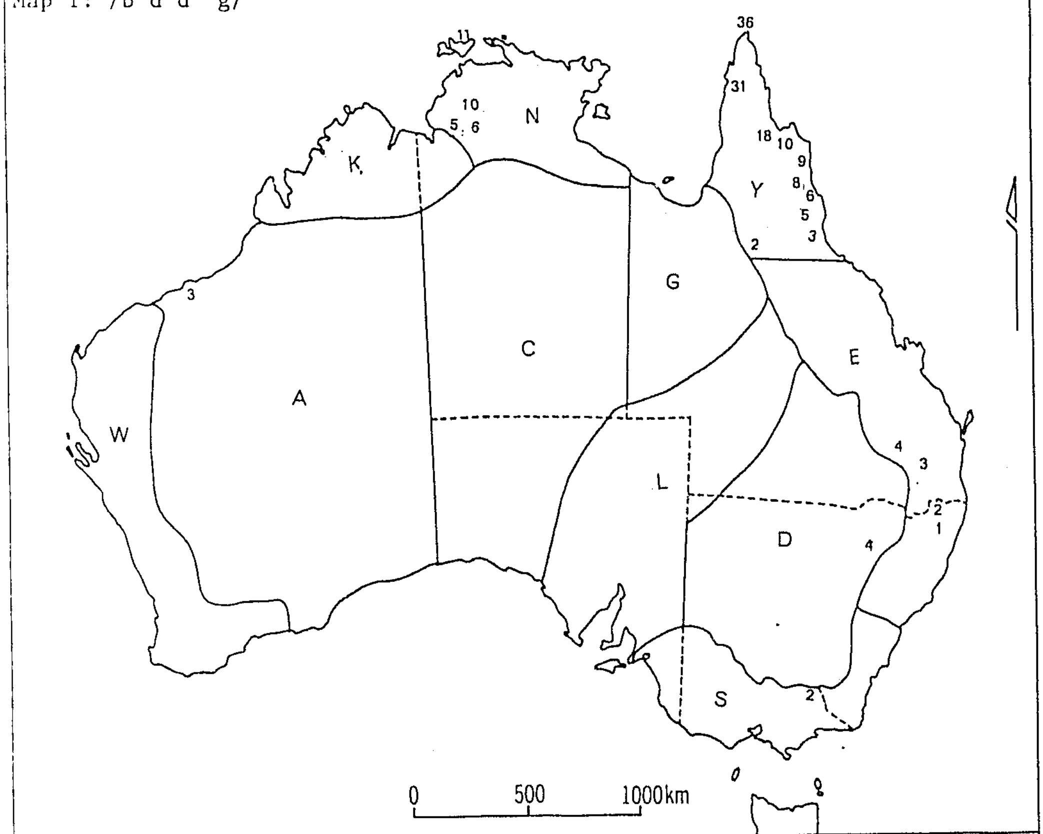
The acoustic phonetic correlations determined in the acoustic analysis (Section 2) and an awareness of the distribution of the arrangements of phonemes (Section 1) has lead to the development of a system which can be considered a suitable method of describing and classifying Australian aboriginal phonology (c.f. 3.4.0. ff.).

APPENDIX 1:

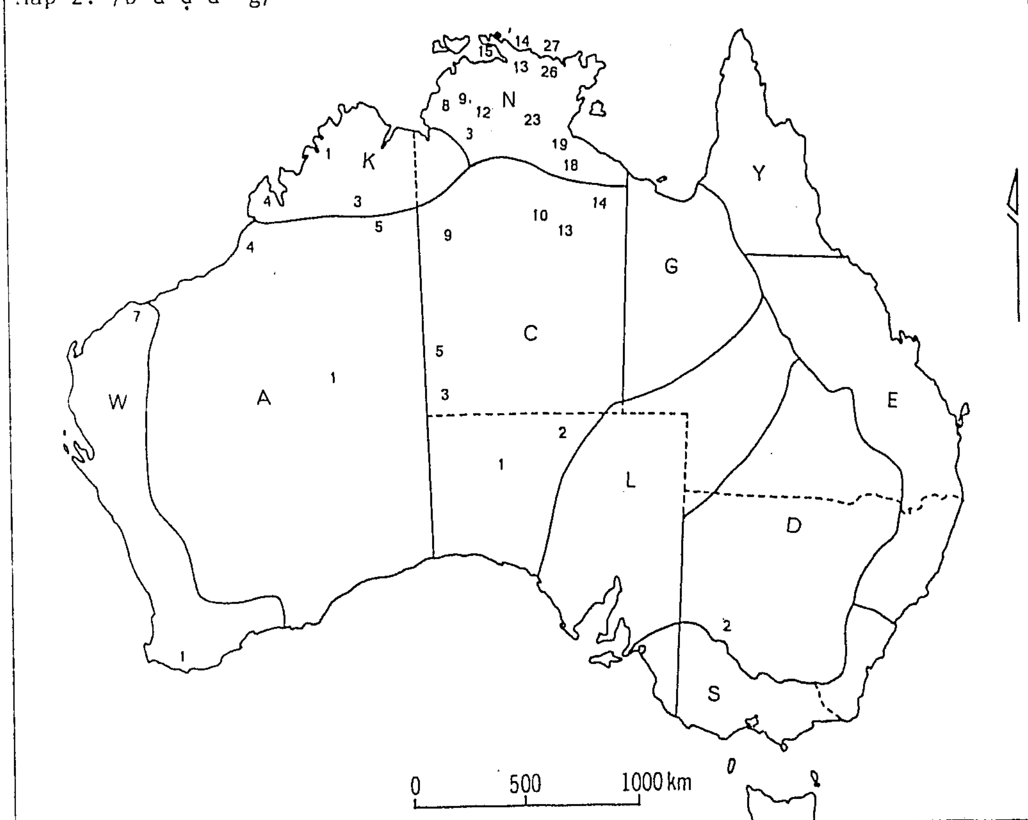
Areal Distributions of Phonemic Systems

(The numbering system is the same as that given for the Language Position map found at the beginning of the thesis).

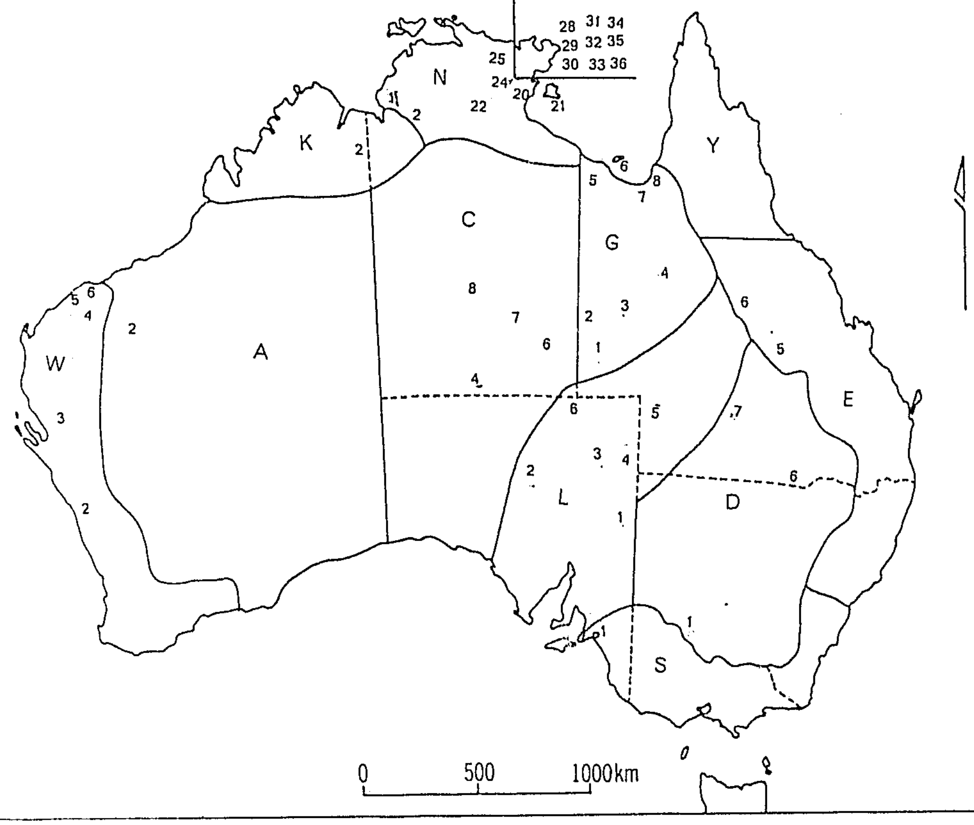
Map 1: /b d d^y g/



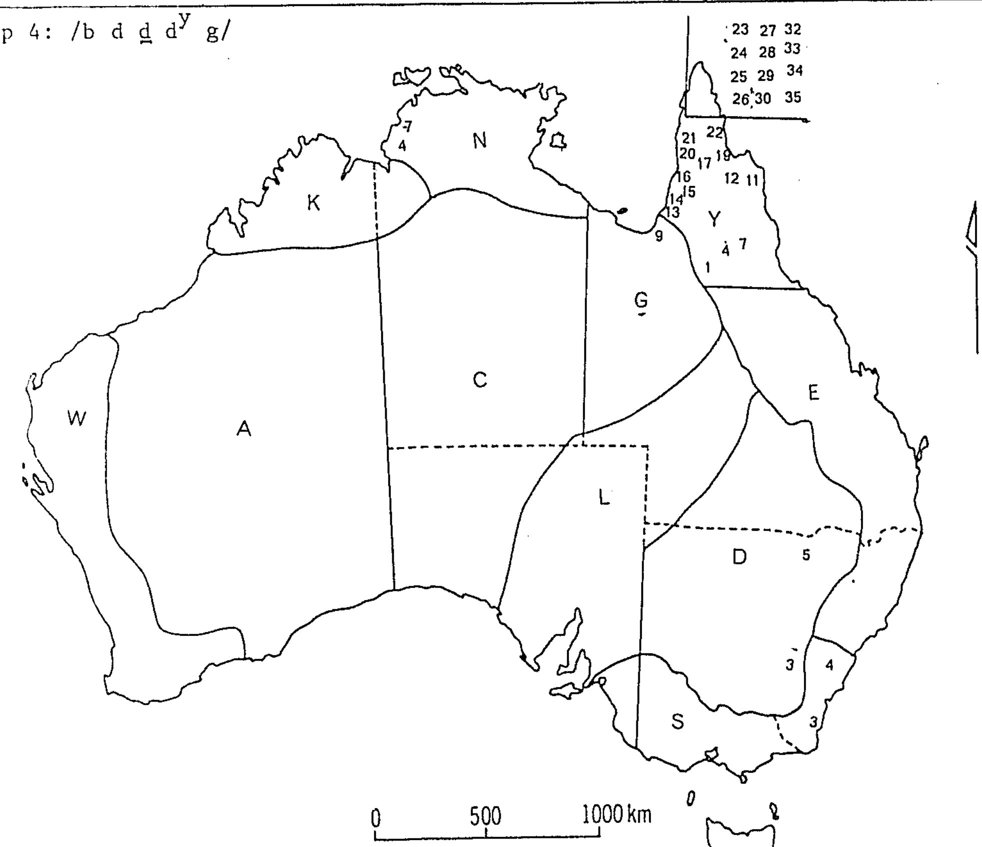
Map 2: /b d ḍ d^y g/



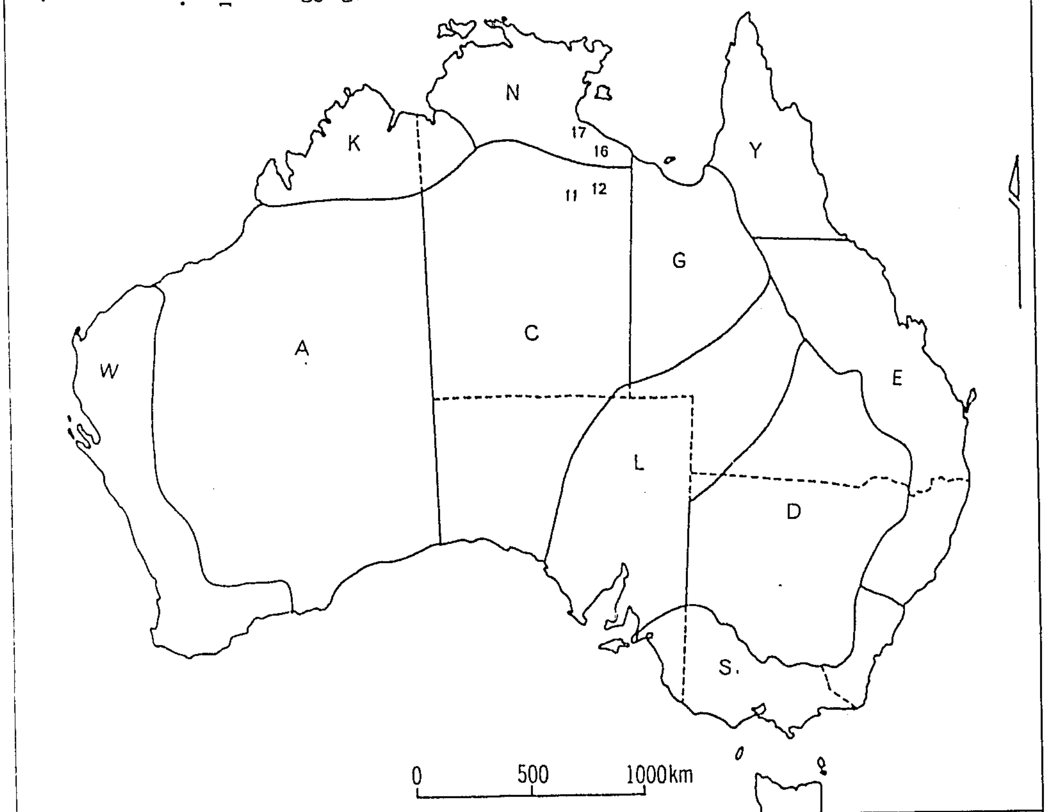
Map 3: /b d ḍ ḏ dʸ g/



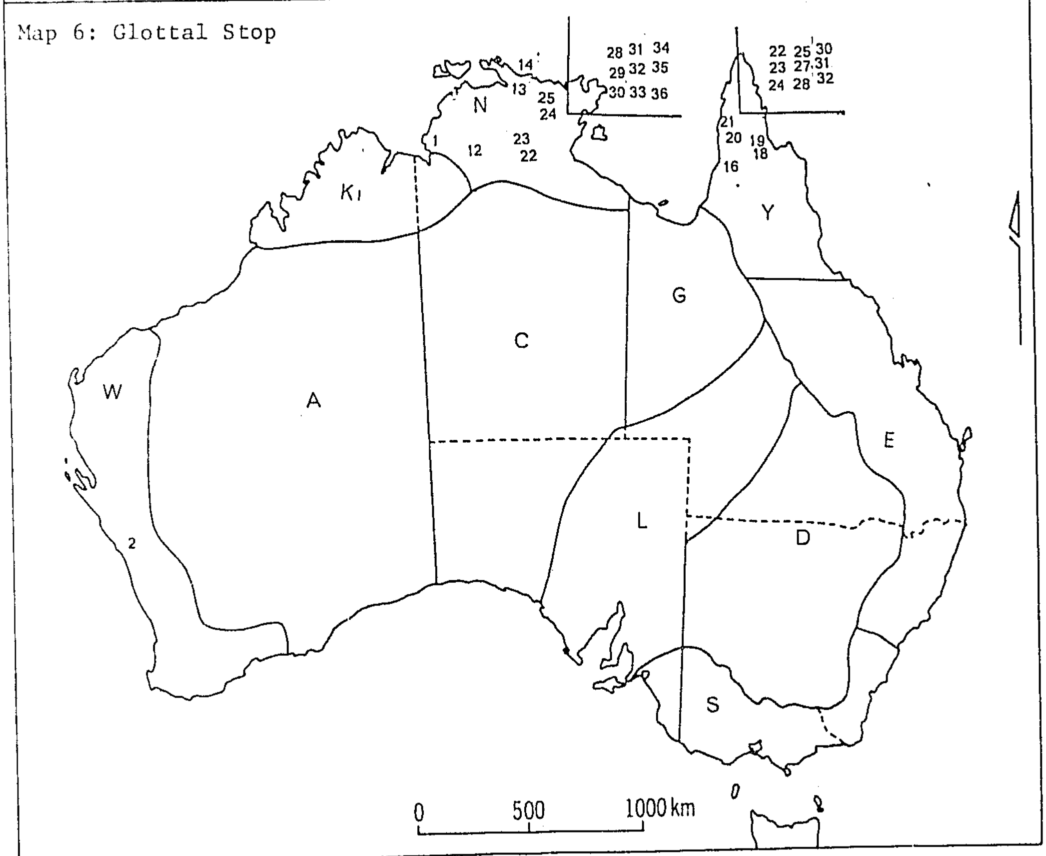
Map 4: /b d ḏ dʸ g/



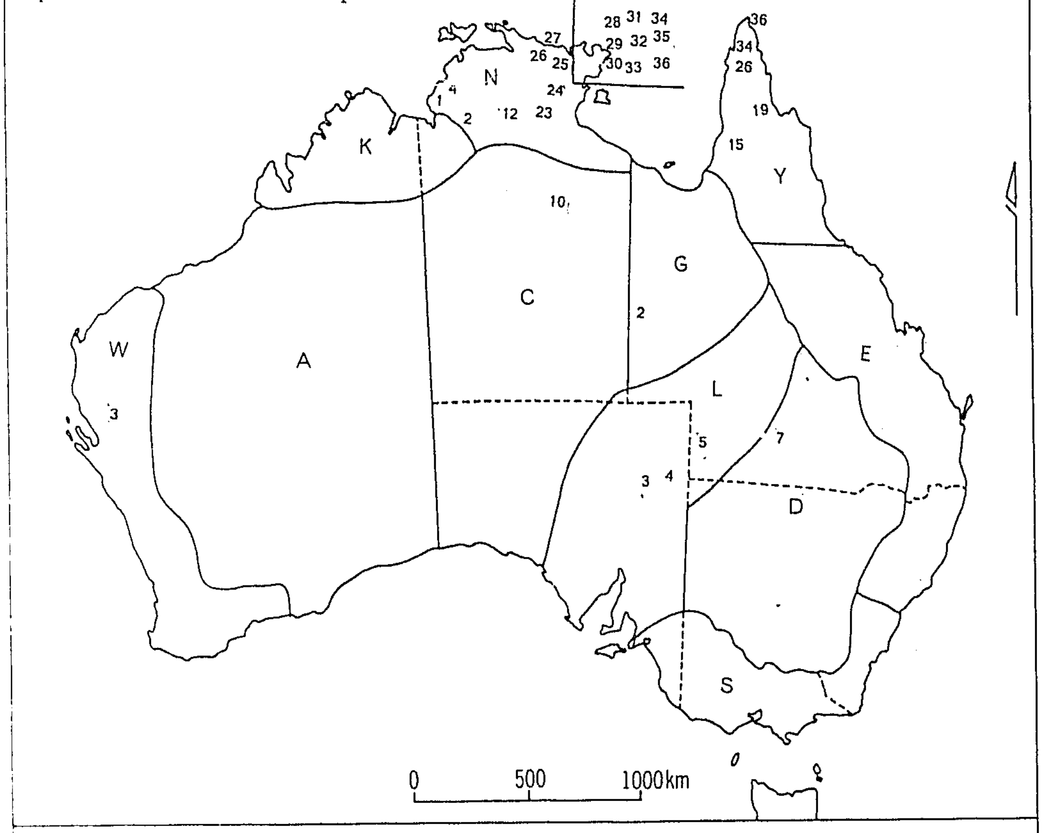
Map 5: /b d ḍ (ḏ) d^y gj g/



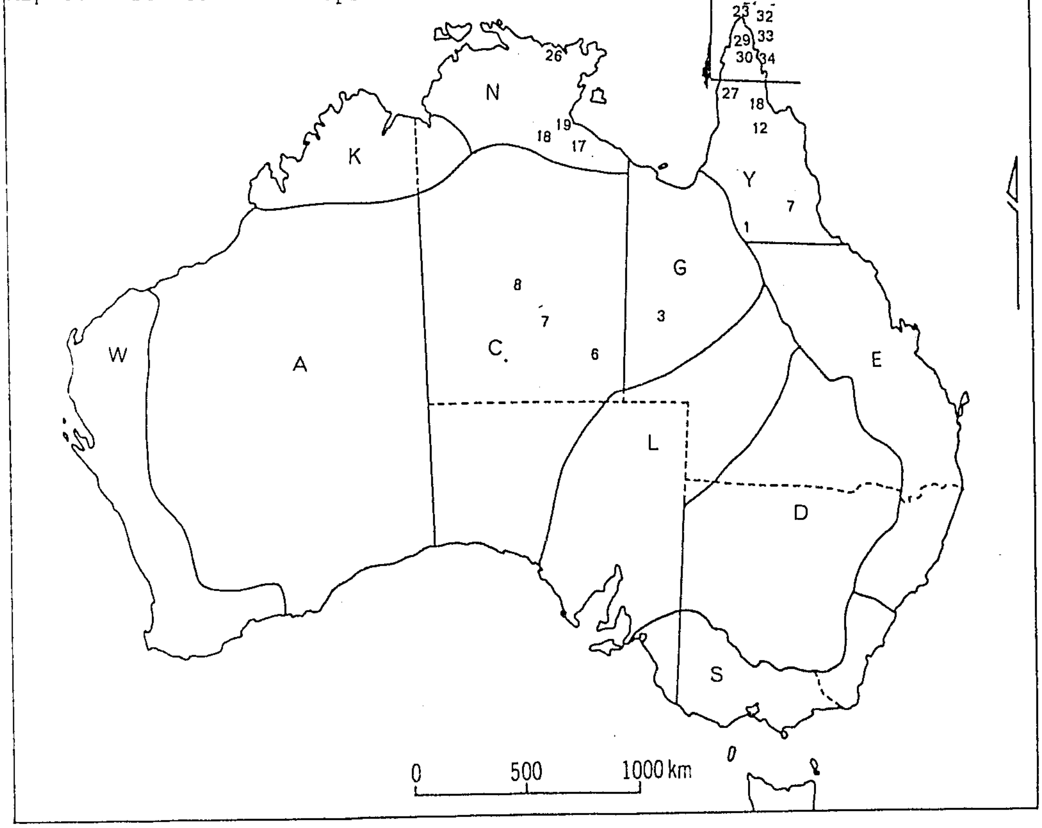
Map 6: Glottal Stop



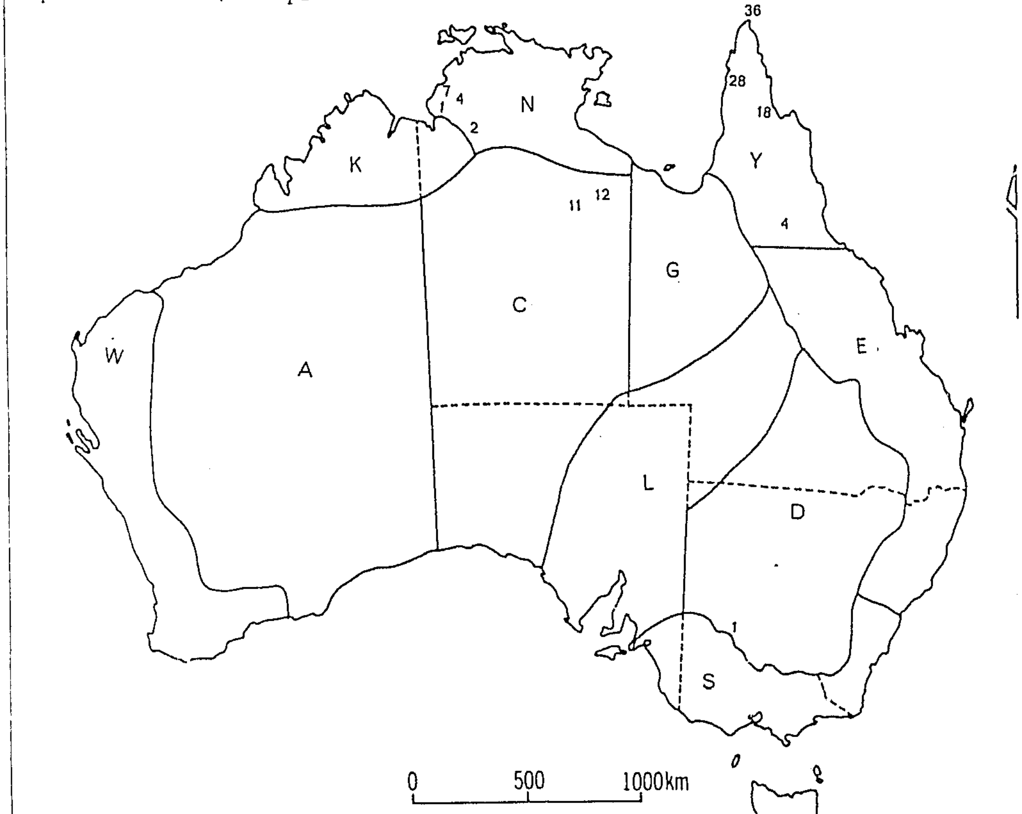
Map 7: Second Series Stops



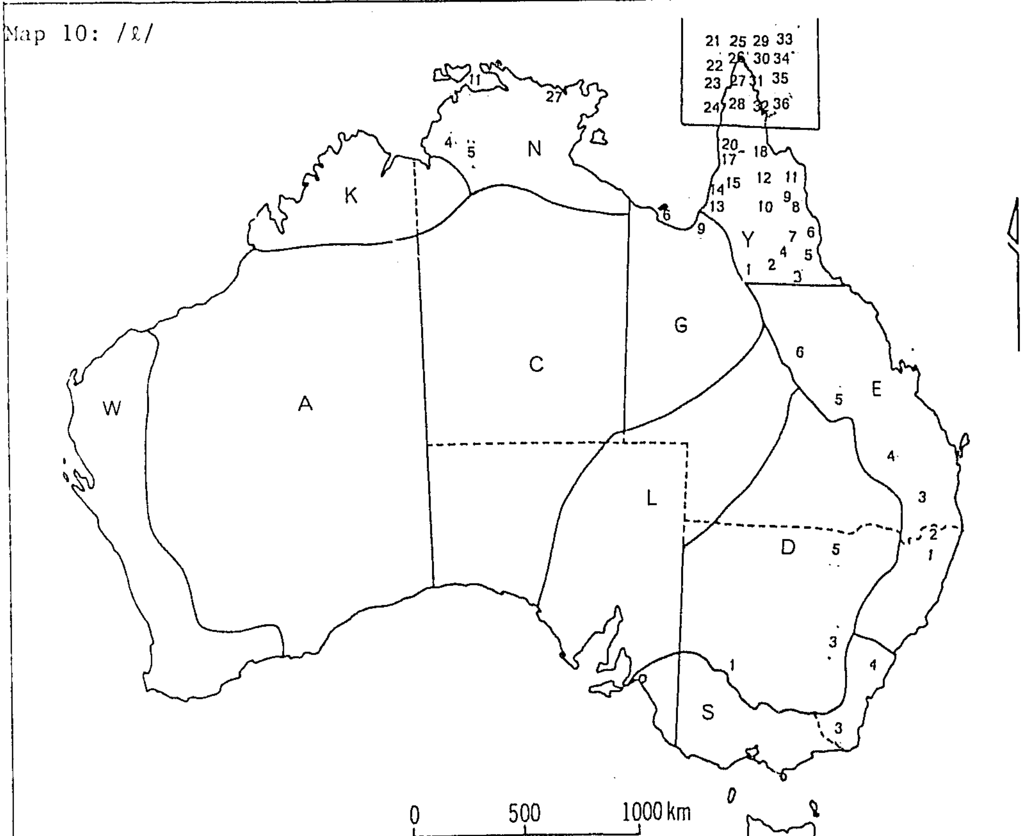
Map 8: Prenasalized Stops



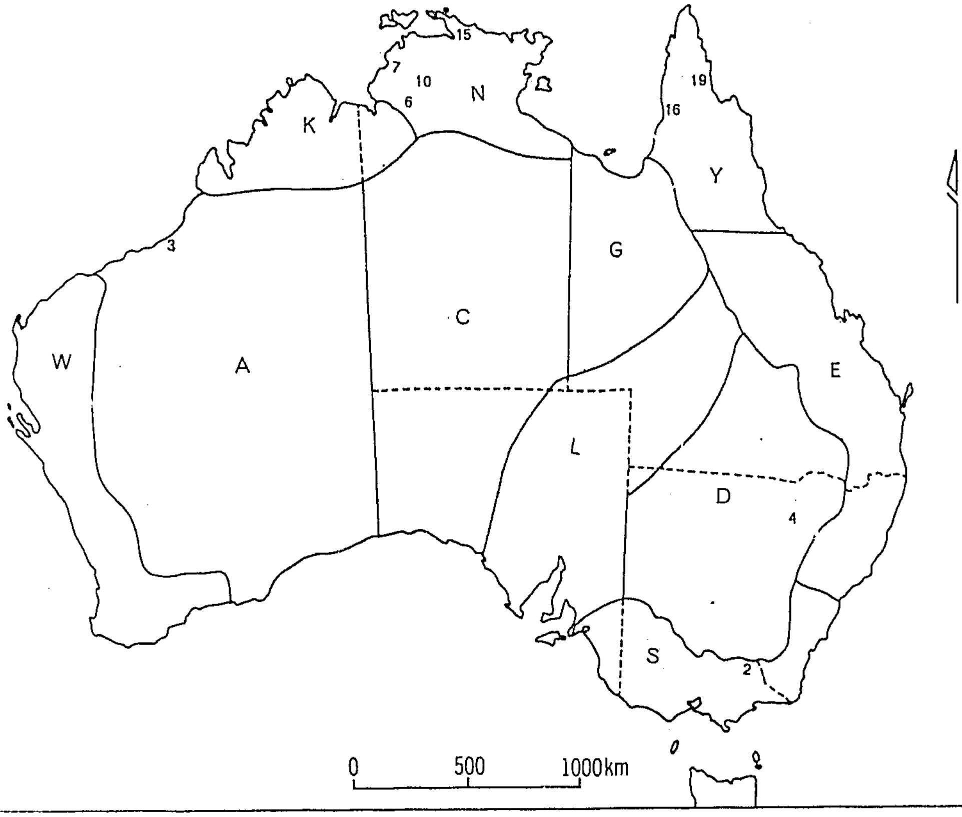
Map 9: Nasals ≠ Stops



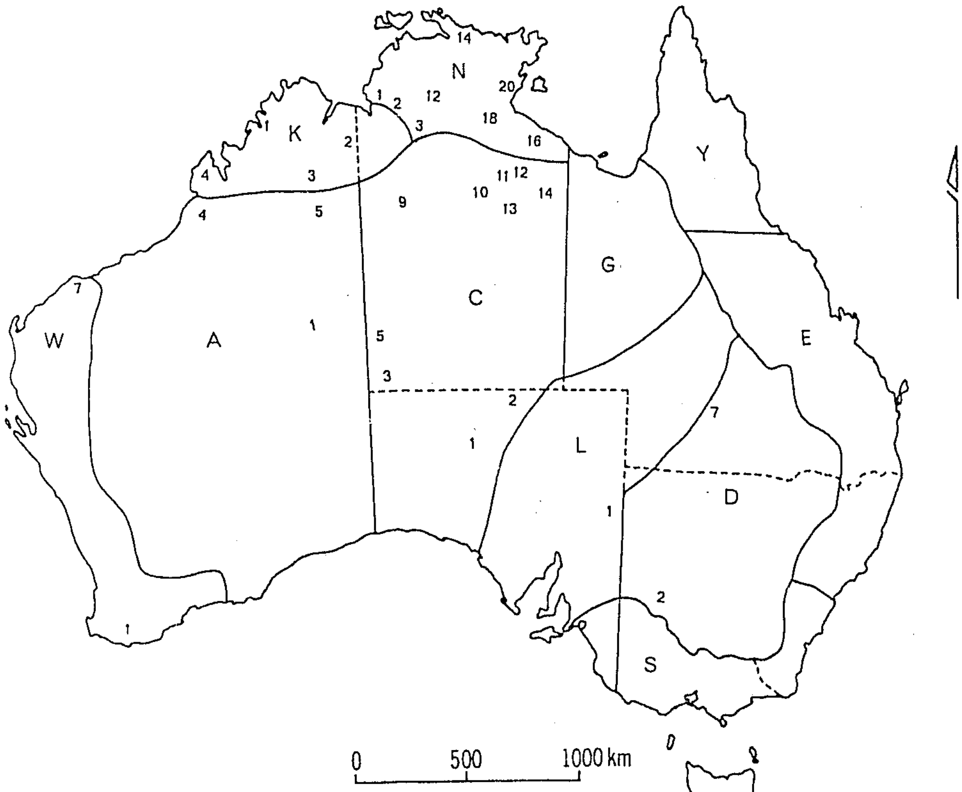
Map 10: /ℓ/



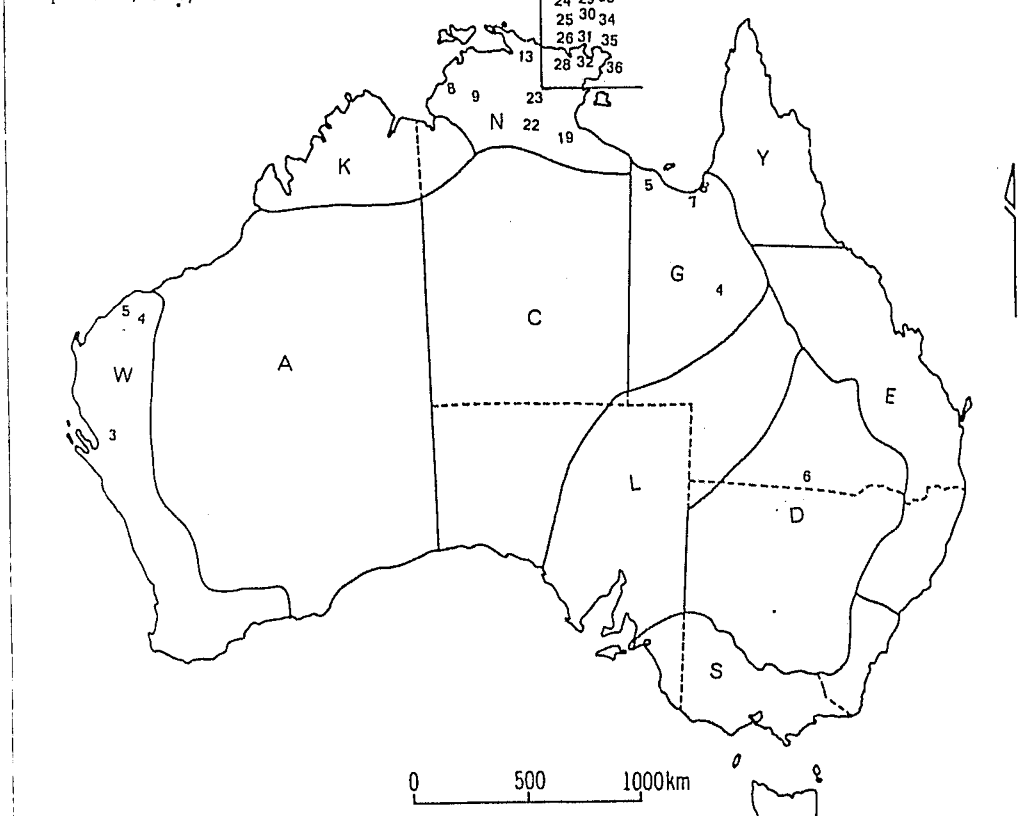
Map 11: /ℓ ℓ^y/



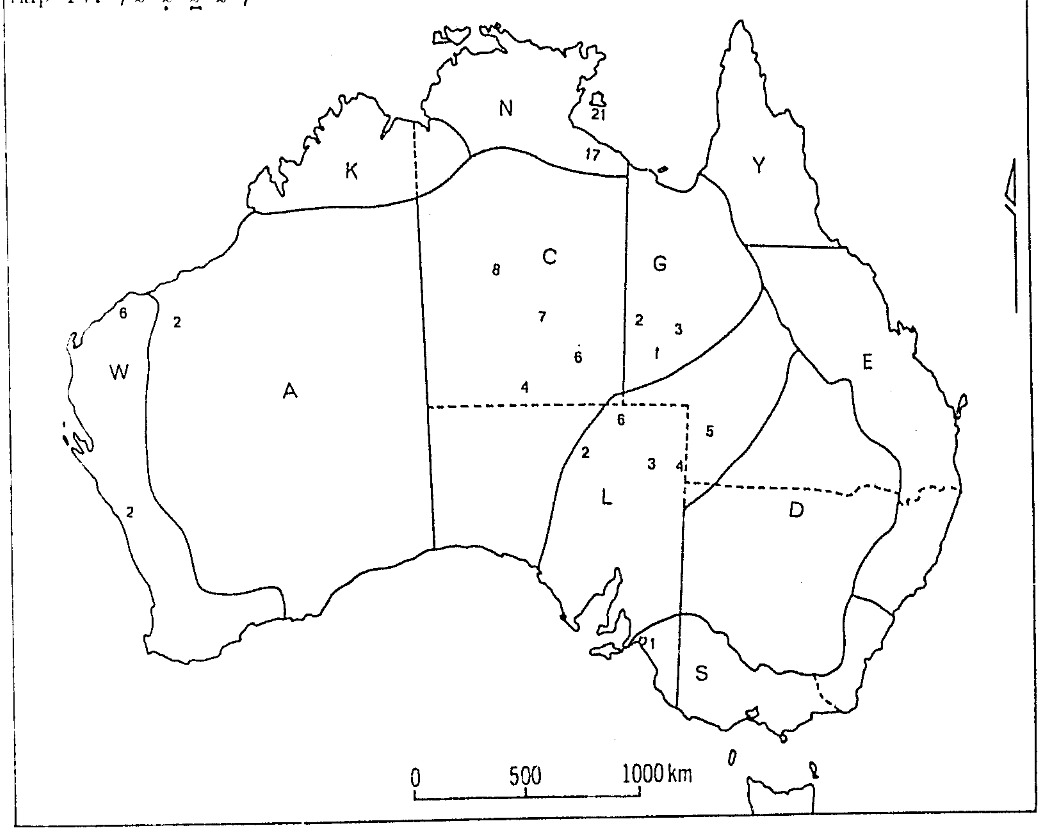
Map 12: /ℓ $\underset{\cdot}{\ell}$ ℓ^y/



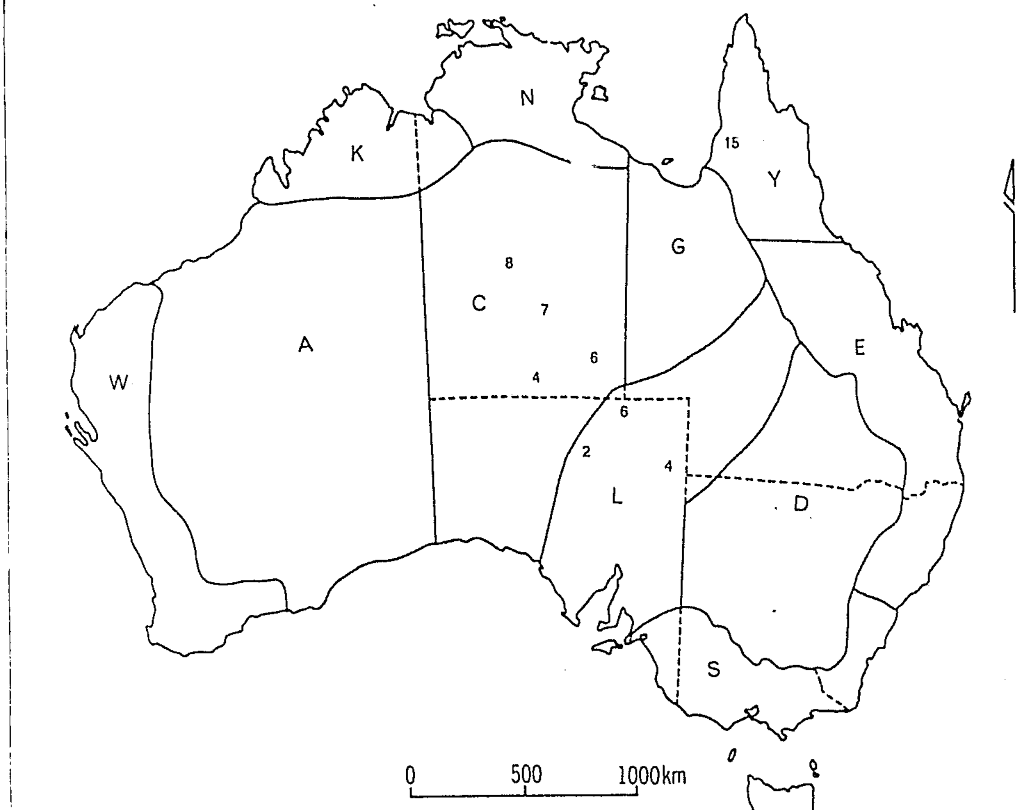
Map 13: /ℓ ḷ/



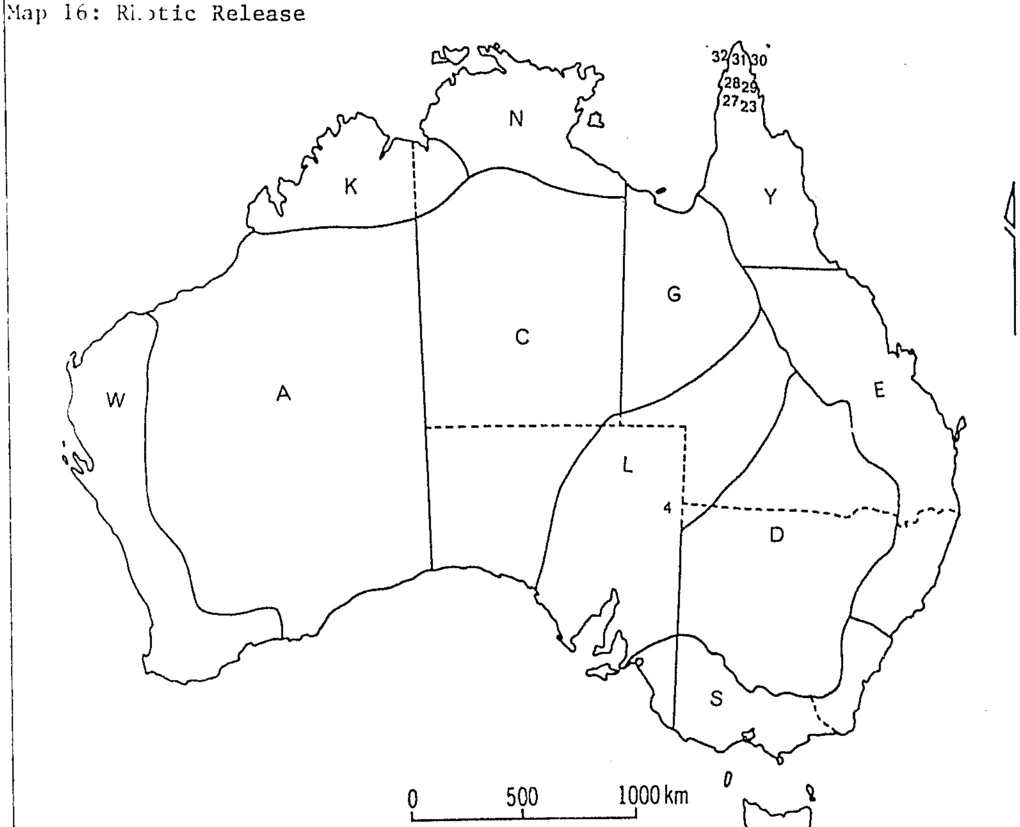
Map 14: /ℓ ḷ ḻ $ℓ^y$/



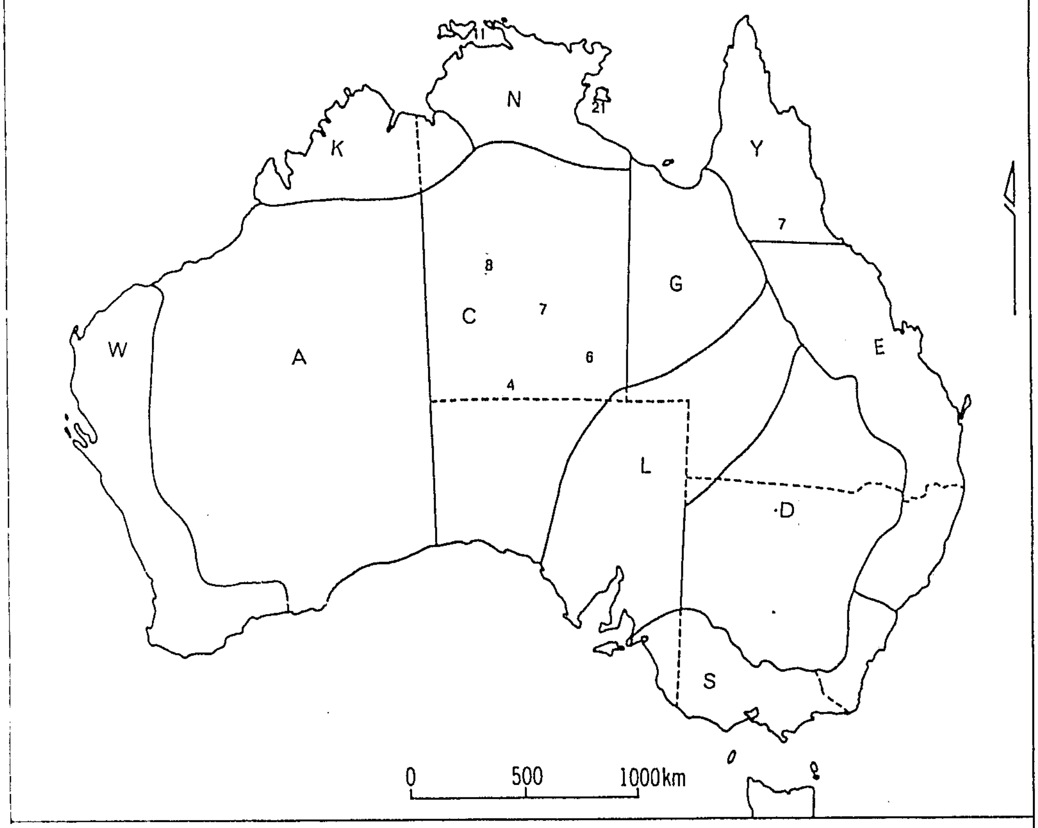
Map 15: Prestopping & Prepalatalization



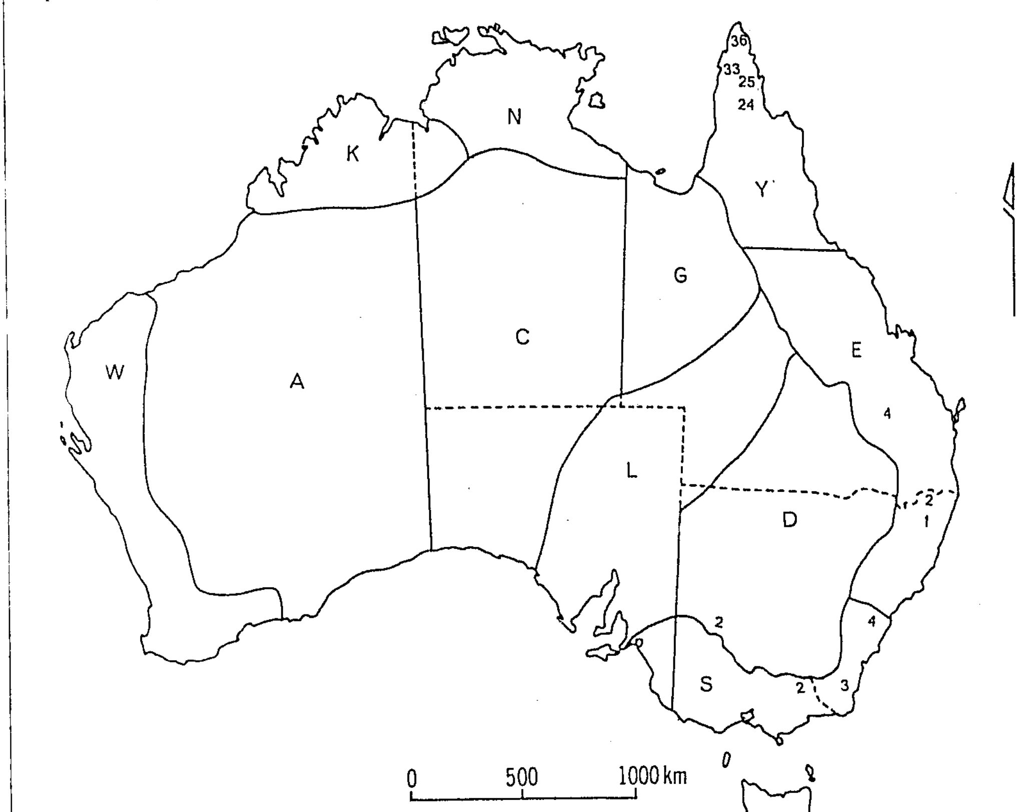
Map 16: Rhotic Release



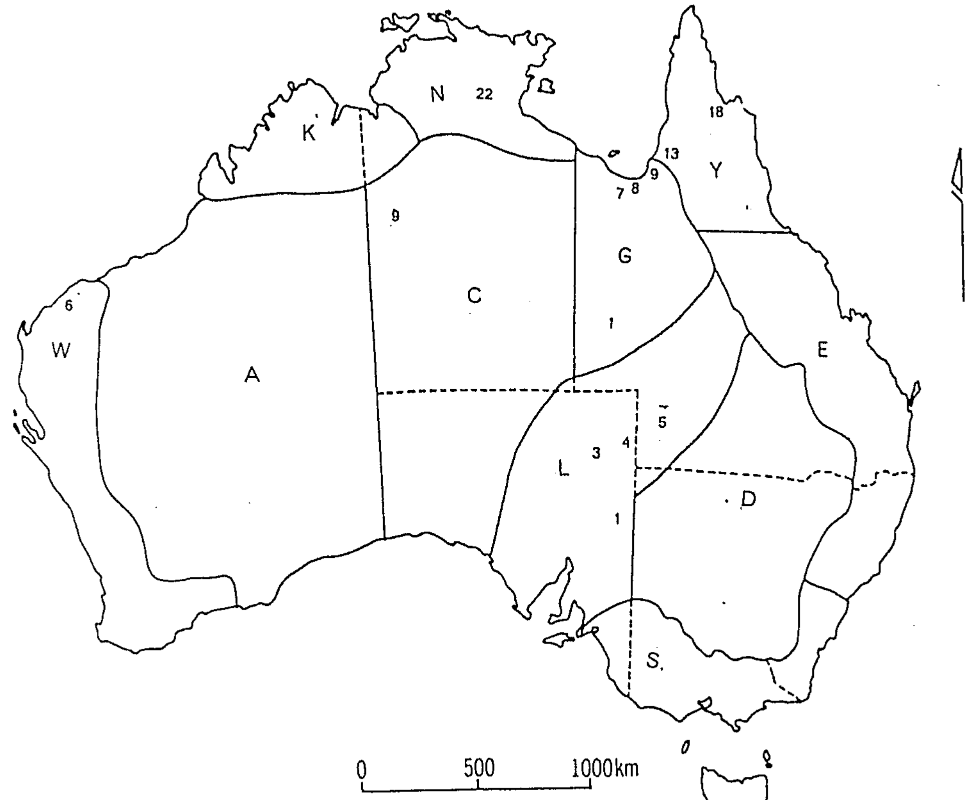
Map 17: Labialization



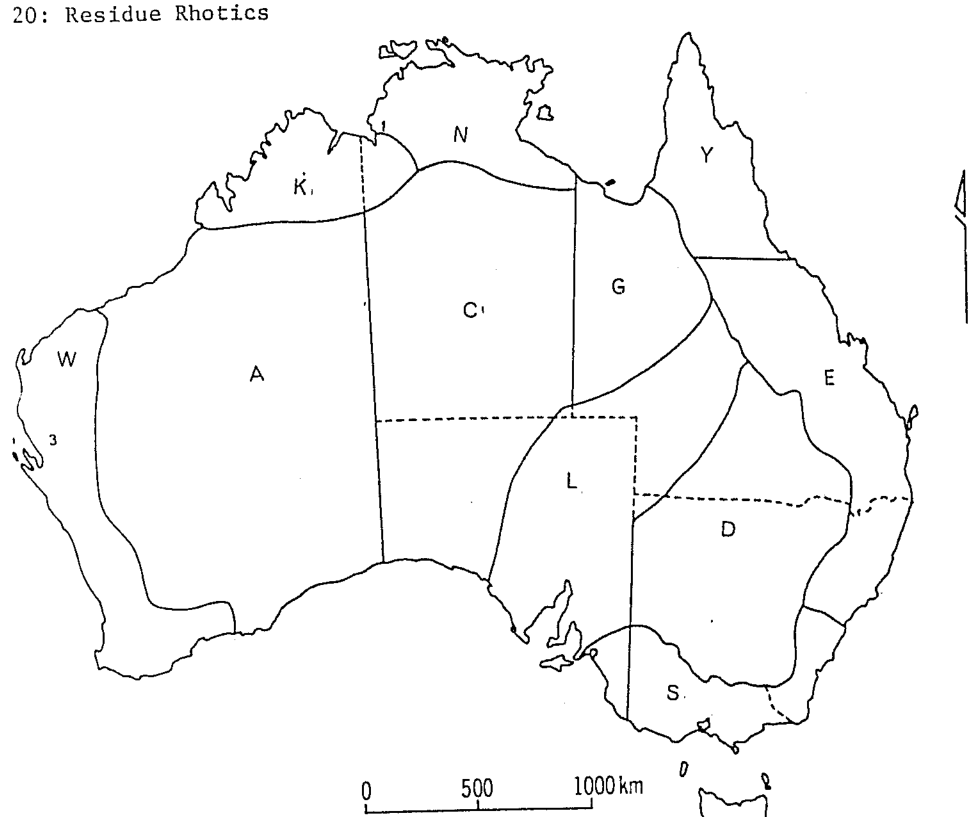
Map 18: /r/



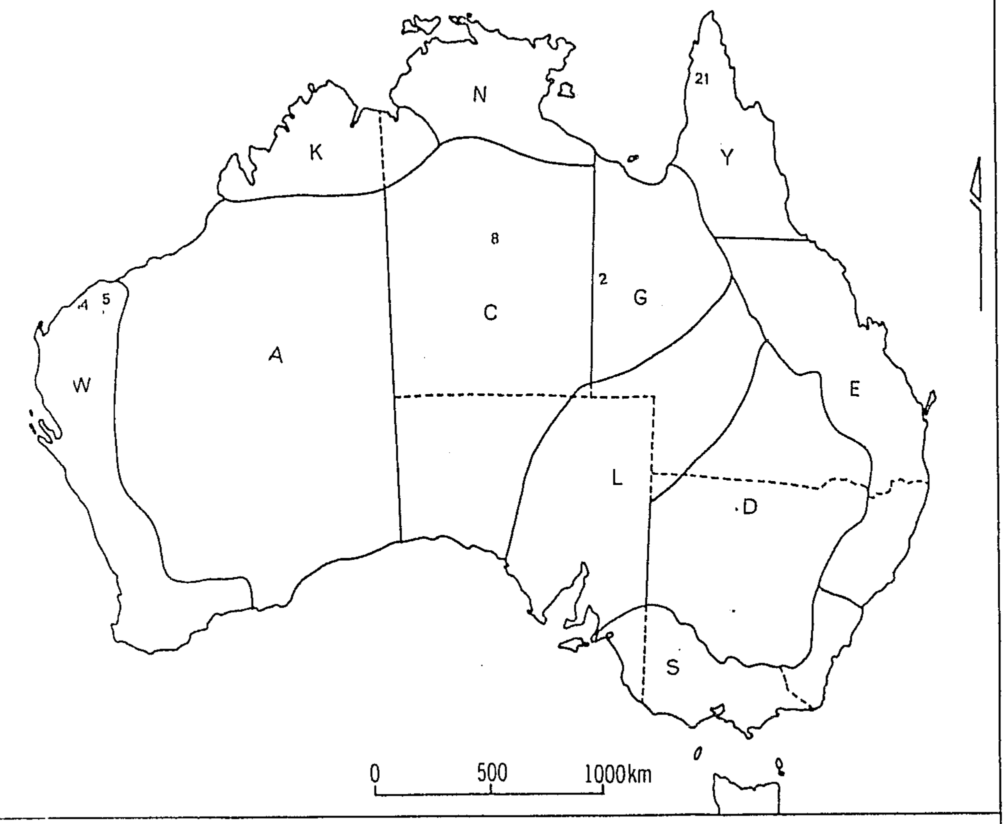
Map 19: /R r ř/



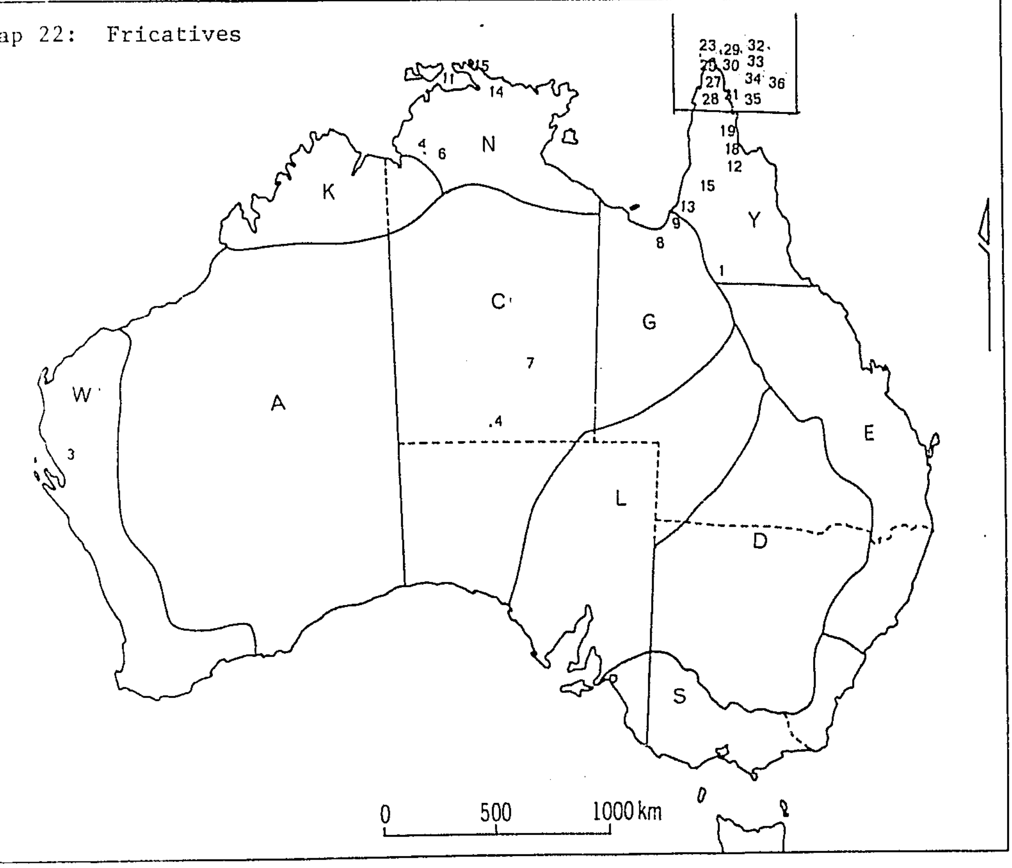
Map 20: Residue Rhotics



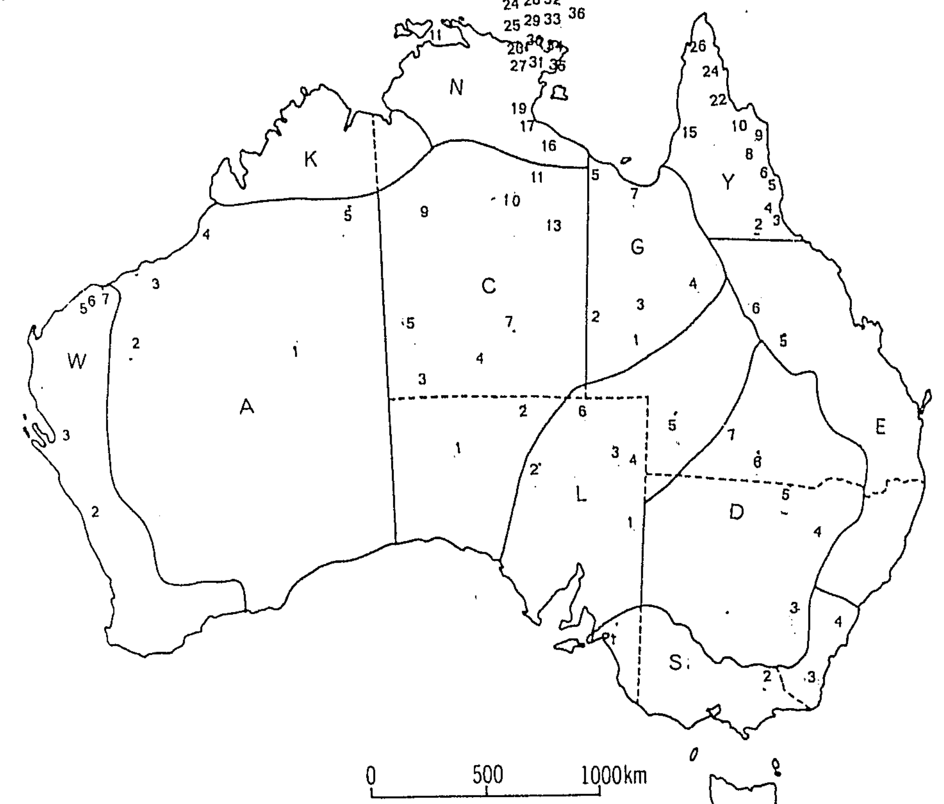
Map 21: 3-Glide Systems



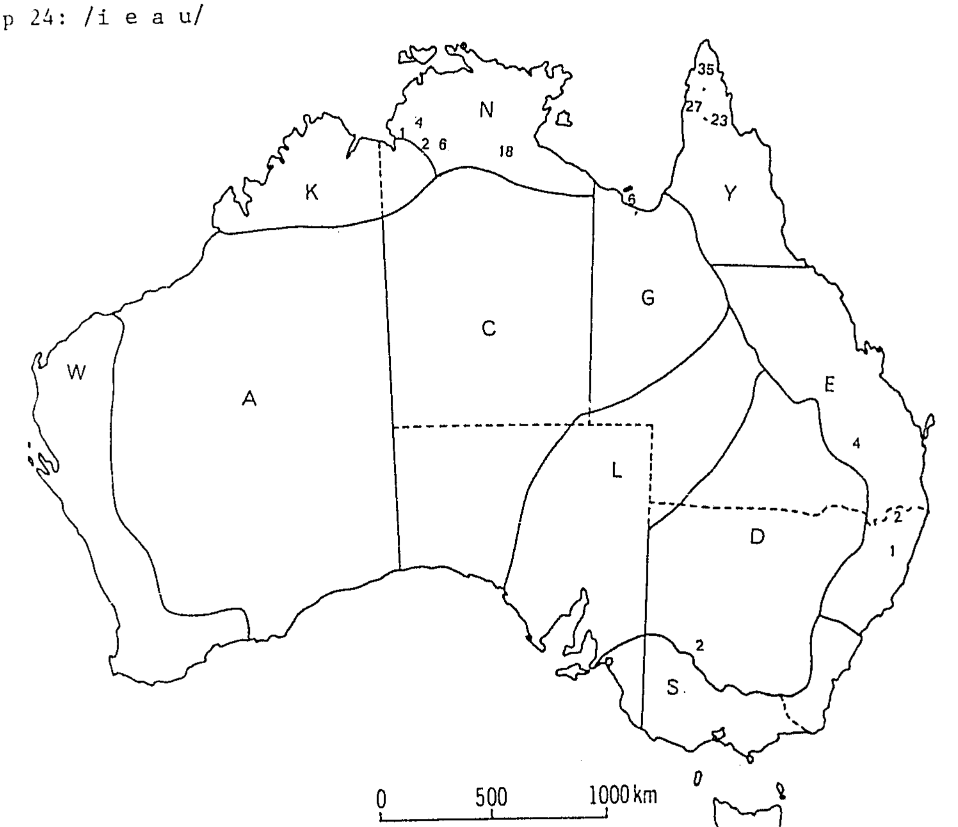
Map 22: Fricatives



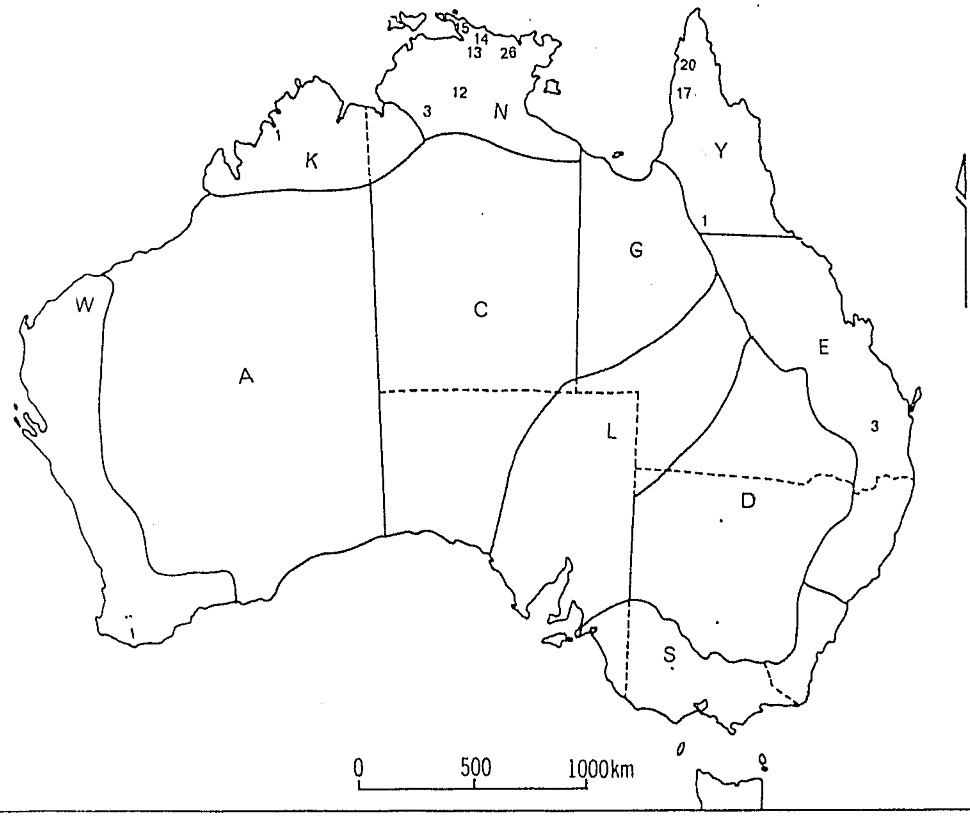
Map 23: /i a u/



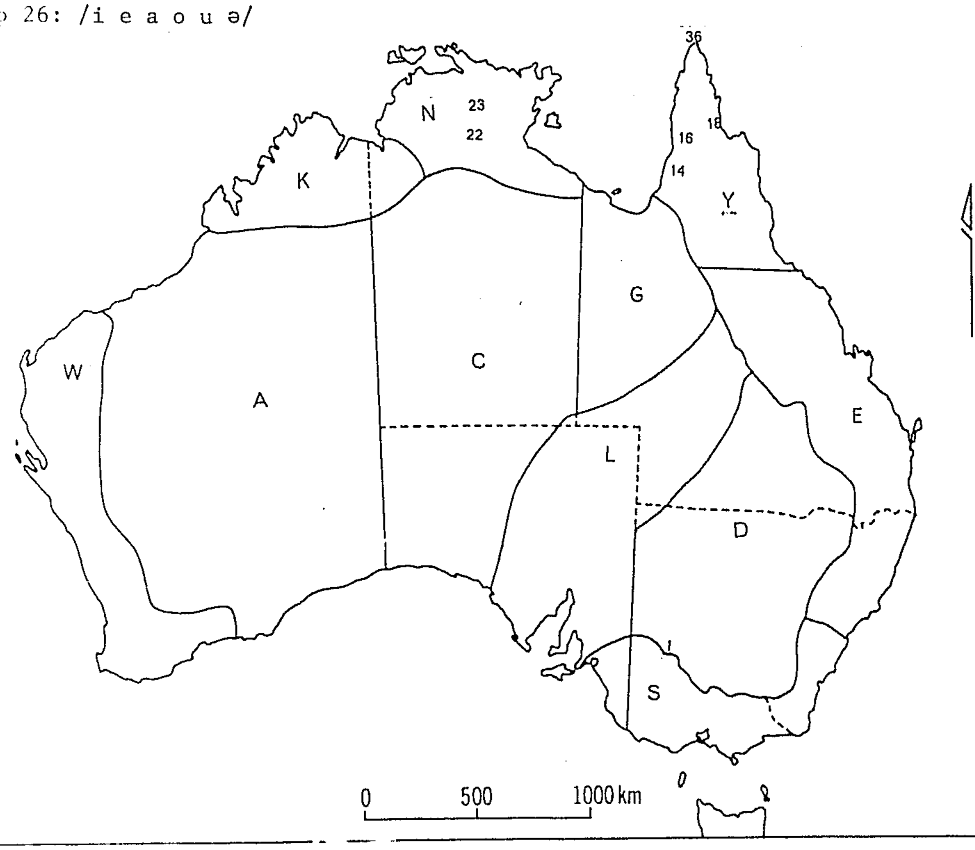
Map 24: /i e a u/



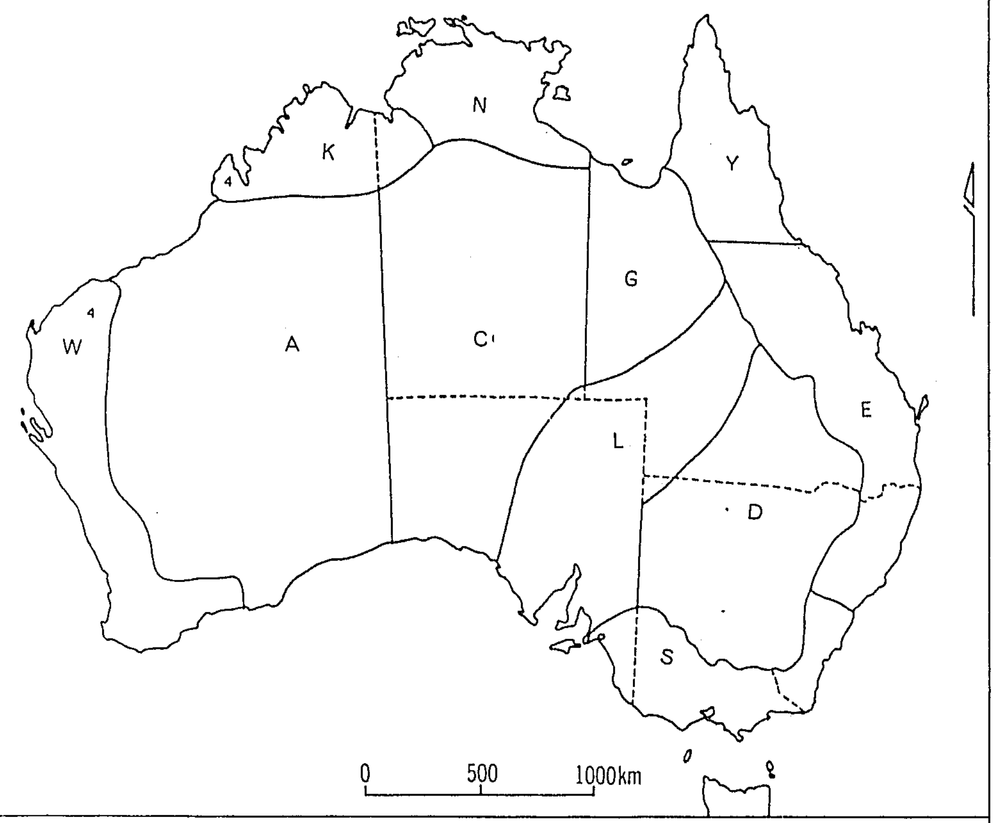
Map 25: /i e a o u/



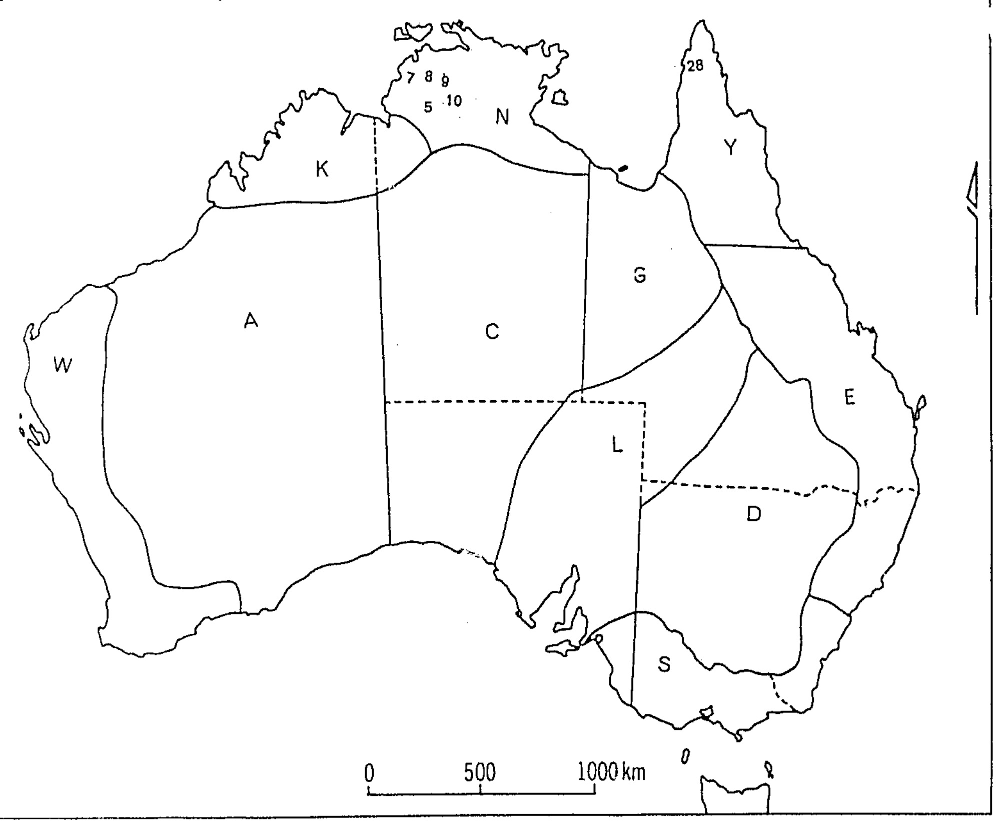
Map 26: /i e a o u ə/



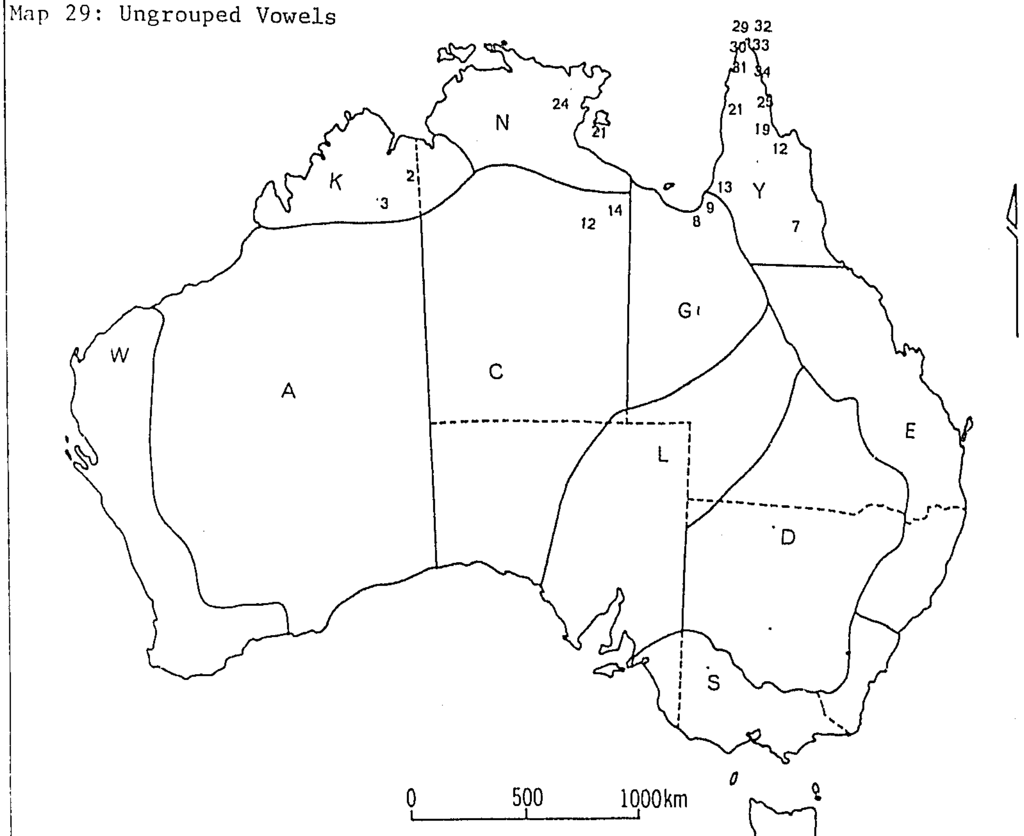
Map 27: /i a o u/



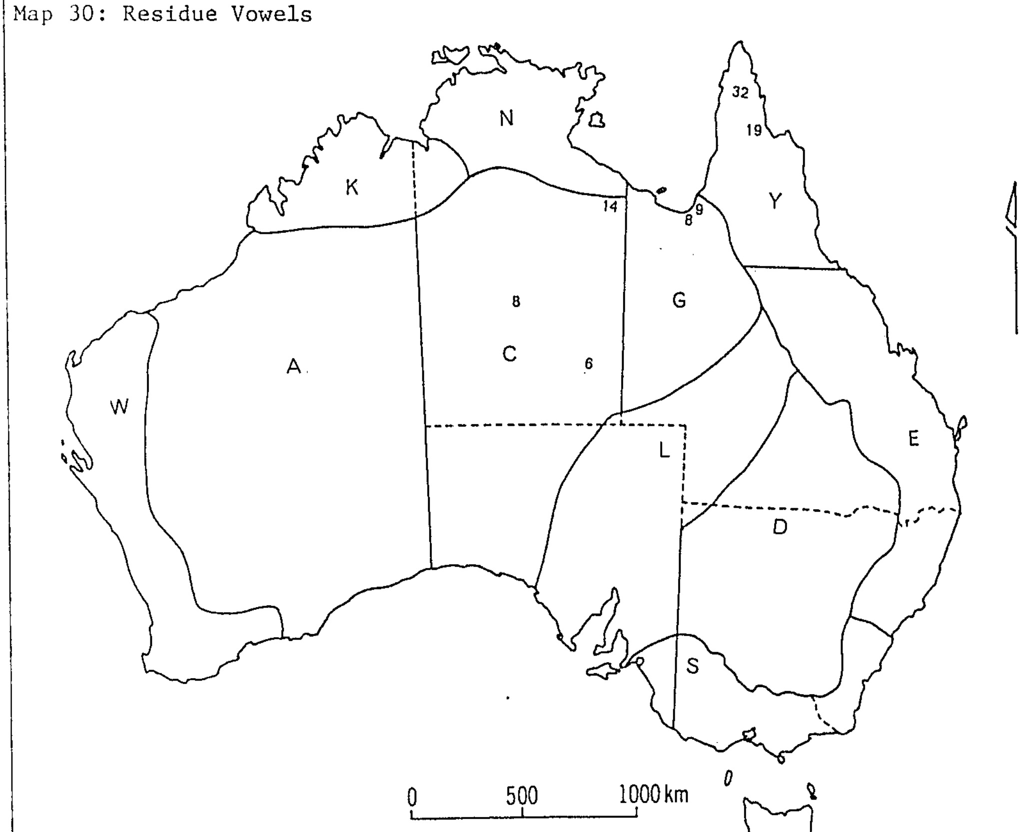
Map 28: /i e a u ə/



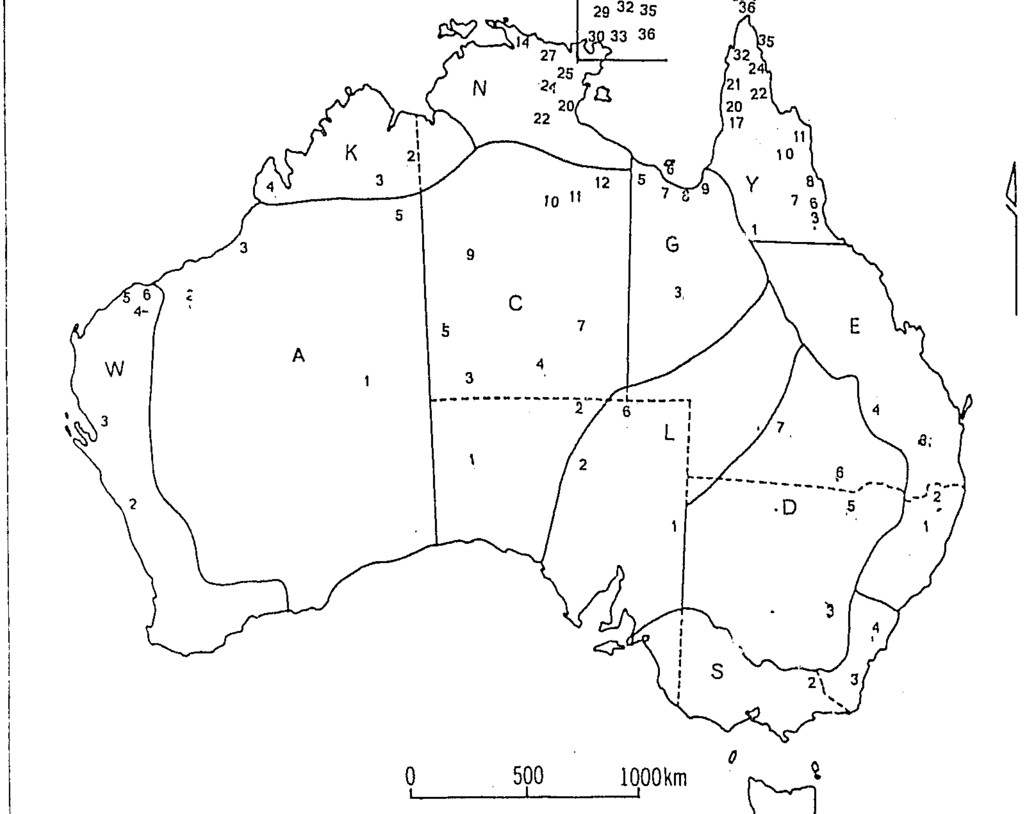
Map 29: Ungrouped Vowels



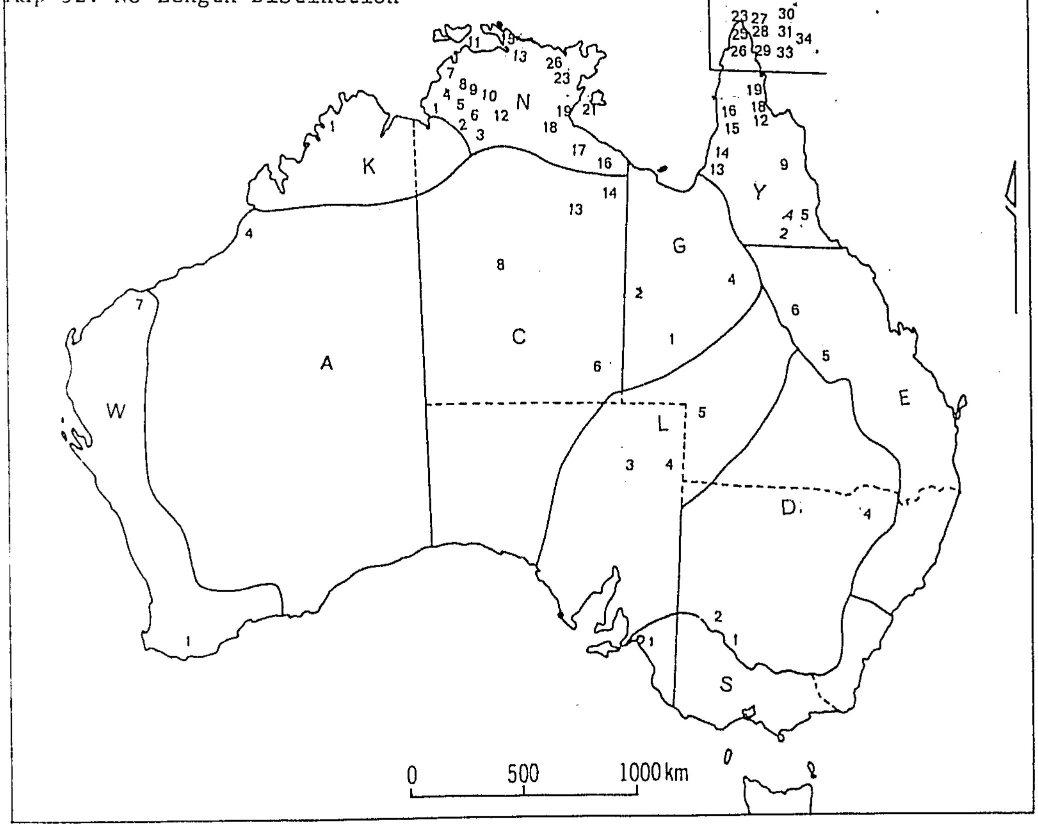
Map 30: Residue Vowels



Map 31: Length Distinction



Map 32: No Length Distinction



APPENDIX 2:

Phonologies of the Languages selected for Acoustic Analysis

<u>Arabana</u> (Hercus, 1972)

b	d	ḍ	d̪	d^y	g
m	n	ṇ	n̪	n^y	ŋ
M	N		N̪	N^y	
	ℓ	ℓ̣	ℓ̪	$ℓ^y$	
	L		L̪	L^y	
	r				
w		R		y	

i u

a

[± length]

<u>Pitjantjatjara</u> (Glass & Hackett, 1970)

b	d	ḍ	d^y	g
m	n	ṇ	n^y	ŋ
	ℓ	ℓ̣	$ℓ^y$	
	r			
w		R	y	

i u

a

[± length]

<u>Kurtjar</u> (Black, 1976)

b	d	d̪	d^y	g
m	n	n̪	n^y	ŋ
β		ð		ɣ
	ℓ			
	r	ř		
w	R		y	

ɨ

e(:) ö(:) o(:)

a(:)

ɨa(:)

<u>Kuuku-Yaʔu</u> (Thompson, 1976)

b	d	d̪	d^y	g	ʔ
m	n	n̪	n^y	ŋ	
	ℓ				
	r				
w			y		

i u

a

[± length]

Kaititj (Koch, personal communication)

b	d	ḍ	d̲	d^y	g	
m	n	ṇ	n̲	n^y	ŋ	
M	N	Ṇ	N̲	N^y	Ŋ	
	ℓ	ℓ̣	ℓ̲	$ℓ^y$		
	r					ə
w	ẅ	R		y		a

Djingili (Chadwick, 1975)

b	d	ḍ	d^y	gj	g	
m	n	ṇ	n^y		ŋ	
	ℓ	ℓ̣	$ℓ^y$			i u
	r					a
w		R	y			[± length]

Djambarrpuynggu (Henley, personal communication)

p	t	ṭ	t̲	t^y	k	?	
b	d	ḍ	d̲	d^y	g		
m	n	ṇ	n̲	n^y	ŋ		
	ℓ	ℓ̣					i u
	r						a
w	R			y			[± length]

Djabu (Henley, personal communication)

p	t	ṭ	t̲	t^y	k	?	
b	d	ḍ	d̲	d^y	g		
m	n	ṇ	n̲	n^y	ŋ		
	ℓ	ℓ̣					i u
	r						a
w	R			y			[± length]

Diyari (Austin, 1978)

p	t	ţ	t̠	t	
	d	ḍ			
m	n	ṇ	n̠	n^y	ŋ
	ℓ	ℓ̣	ℓ̠	$ℓ^y$	
	r				
	ř				
w		R		y	

i	u
a	

Mara (Busby, 1978a)

b	d	ḍ	d^y	g
m	n	ṇ	n^y	ŋ
	ℓ	ℓ̣		
	r			
w		R	y	

i	u
a	

Murinbata (Walsh, 1976)

p	t̠	t	ṭ	t^y	k	?
b		d	ḍ	d^y	g	
m		n	ṇ	n^y	ŋ	
		ℓ	ℓ̣	$ℓ^y$		
		r				
w		ɹ	R	y		

i	u
e	a

Mpakwithi (Crowley, forthcoming)

b	d	d^r	d̪	d^y	g	?
mb	nd	nd^r	n̪d̪	n^yd^y	ŋg	
m	n		n̪	n^y	ŋ	
β			ð	ʒ	ɣ	
	ℓ					
	r					
w	R			y		

i(:)	ĩ	ü	u(:)
e(:)	ẽ	(ö)	o
æ(:)	æ̃		
a(:)	ã		

Wik-Ep (Hale, 1960)

b	d	d̪	d^y	g	?
m	n	n̪	n^y	ŋ	
	ℓ				
	r				
w	ẅ	R	y		

i	ü	(ɨ)	(ʉ)	u
e	ö			o
		a		

[± length] (?)

Wikmunkan (Sayers, 1976)

b	d	d̪	d^y	g	?
m	n	n̪	n^y	ŋ	
	ℓ				
	r				
w	R		y		

i		u
e		o
	a	

[± length]

Waramunga (Hale, 1959)

b	d	ḍ	d^y	g
m	n	ṇ	n^y	ŋ
	ℓ	ḷ	$ℓ^y$	
	r			
w		R	y	

i	u
a	

[± length]

<u>Yukulta</u> (Keen, 1972)

b	d	ḍ	ḏ	d^y	g
m	n	ṇ	ṉ	n^y	ŋ
	ℓ	ℓ̣			
	r				
w		R			

i u

a

[± length]

<u>Yathaikana</u> (Crowley, personal communication)

b	d	ḏ	d^y	g
m	n	ṉ	n^y	ŋ
β		ð		γ
	ℓ			
	r			
w	R			

i u

ẹ a

[± length]

<u>Yanyula</u> (Huttar & Kirton, 1978)

b	d	ḍ	ḏ	d^y	gj	g
mb	nd	ṇḍ	ṉḏ	$n^y d^y$	ŋjgj	ŋg
m	n	ṇ	ṉ	n^y	ŋj	ŋ
	ℓ	ℓ̣	ℓ̠	$ℓ^y$		
	r					
w		R				

i u

a

<u>Yandruwandha</u> (Breen, 1976b)

p	t	ṭ	ṯ	t^y	k
b	d	ḍ	ḏ	d^y	g
m	n	ṇ	ṉ	n^y	ŋ
	ℓ	ℓ̣	ℓ̠	$ℓ^y$	
	L	Ḷ	L̠	L^y	
	d^r	$ḍ^r$			
	r	ṛ̌			
w		R		y	

i u

a

APPENDIX 3:

Statistical Formulae and Terminology

TERMINOLOGY

F - values are formant values given in cycles per second (cps)

n = number of instances

Σ = the sum of

X = any number

FORMULAE

The Mean ($\bar{x}$)

$$\bar{x} = \frac{\Sigma X_1 + X_2 + X_3 + X_4 \text{ --- } X_n}{n}$$

The Standard Deviation (s.d.)

$$\text{s.d.} = \sqrt{\frac{(X - \bar{X})^2}{n-1}}$$

The Standard Error (S.E.)

$$\text{S.E.} = \frac{\text{s.d.}}{\sqrt{n}}$$

The 95% confidence limits

95% confidence limits = $\bar{X} \pm 1.96 \times$ S.E.

This gives us two values, one above the mean and one below; where we are "95% confident that the actual population mean falls with certain specific limits" (Ferguson, G., 1966: 153).

APPENDIX 4:

Statistical Data of Laterals

(Formant values are to the nearest whole number)

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
ɛ	1	21	483	73.88	16.12	452	515
	2	17	1509	161.91	39.26	1432	1586
	3	18	2632	297.64	70.15	2494	2769
ɛ̣	1	13	458	72.45	20.09	418	497
	2	11	1493	148.79	44.86	1405	1581
	3	13	2377	358.01	99.29	2182	2572
ɛ̱	1	12	469	44.11	12.73	444	494
	2	11	1611	161.00	50.51	1512	1710
	3	11	2589	210.76	63.55	2464	2713
ɛʸ	1	9	489	87.60	29.20	445	533
	2	8	2009	178.25	63.02	1886	2133
	3	8	2900	181.27	64.09	2774	3026

APPENDIX 5:

Statistical Data of Nasals

(Formant values are to the nearest whole number)

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
m	1	9	567	136.93	45.64	477	656
	2	12	1285	158.28	45.69	1196	1375
	3	11	2211	284.03	85.64	2044	2379
n	1	21	469	76.20	16.63	436	502
	2	23	1502	169.38	35.32	1433	1571
	3	19	2279	211.79	48.59	2183	2374
ṇ	1	11	502	86.93	26.21	451	554
	2	10	1735	163.38	51.67	1634	1836
	3	12	2129	316.56	91.38	1950	2308
n̲	1	11	532	92.93	28.02	477	587
	2	13	1654	222.17	61.62	1533	1775
	3	13	2499	171.40	47.54	2406	2592
n^y	1	17	550	79.06	19.17	512	588
	2	17	2156	197.55	47.91	2062	2204
	3	11	2936	219.19	66.09	2807	3065
ŋ	1	9	556	115.77	38.59	480	631
	2	8	1441	221.97	78.48	1287	1594
	3	10	2215	198.33	62.72	2092	2338

APPENDIX 6:

Vowel Transitions

(A) Statistical Data of Stops

(B) Statistical Data of Nasals

(C) Statistical Data of Laterals

Two points of measurement:

S = the vowel formant

A = the end of the vowel formant transition

(Formant values are to the nearest whole number)

(A): Statistical Data of Stops

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
S-Position C/a——							
d	1	16	769	142.45	35.61	699	839
	2	16	1519	141.27	35.32	1450	1588
	3	3	2300	100.00	57.74	2187	2413
ḍ	1	18	789	115.75	27.28	735	842
	2	19	1589	107.47	24.66	1541	1638
	3	6	2300	154.92	63.25	2176	2424
ḏ	1	10	815	115.59	36.55	743	887
	2	10	1655	165.75	52.41	1552	1758
	3	1	2300	0.00			
d^y	1	9	850	103.08	34.36	816	884
	2	9	1567	70.71	23.57	1520	1613
g	1	15	773	130.75	37.76	707	840
	2	17	1526	154.23	37.40	1453	1600
b	1	18	781	108.65	25.60	730	831
	2	17	1562	136.39	33.08	1497	1627
S-Position C/——a							
d	1	18	756	113.62	26.78	703	808
	2	20	1573	120.83	27.02	1520	1625
	3	1	2300	0.00			

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
ḍ	1	11	773	108.08	32.59	709	837
	2	11	1614	189.86	57.24	1501	1726
	3	3	2267	57.74	33.34	2201	2332
d̲	1	27	743	88.47	17.03	709	776
	2	28	1630	135.63	25.63	1553	1654
d^y	1	21	788	89.31	19.49	750	826
	2	20	1628	131.26	29.35	1570	1685
g	1	46	773	11.91	1.76	769	776
	2	47	1586	117.35	17.20	1553	1620
b	1	36	774	74.15	12.36	749	798
	2	35	1503	116.91	19.76	1465	1541
S-Position C/i——							
d	1	1	550	0.00			
	2	1	1900	0.00			
ḍ		ϕ					
d̲		ϕ					
d^y	1	7	493	34.50	13.04	467	518
	2	5	2080	164.32	73.48	1936	2224
g		ϕ					
b	1	2	475	35.36	25.00	426	524
	2	2	2150	70.71	50.00	2052	2248

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
S-Position C/——i							
d	1	4	513	62.92	31.46	451	574
	2	4	2075	206.16	103.08	1873	2277
ḍ	1	6	500	114.02	46.55	409	591
	2	8	2119	203.43	71.92	1978	2330
d̲	1	5	500	0.00			
	2	5	2100	100.00	44.72	2012	2188
d^y	1	10	525	139.94	44.25	438	612
	2	6	2033	103.28	42.16	1951	2116
g	1	3	483	28.87	16.67	451	516
	2	3	2067	208.17	120.19	1831	2320
b	1	6	500	0.00			
	2	7	2148	127.24	48.00	2054	2242
S-Position C/u——							
d	1	7	493	34.50	13.04	467	518
	2	7	986	69.01	26.08	935	1037
ḍ	1	2	550	0.00			
	2	2	1000	0.00			
	3	1	2300	0.00			
d̲	1	5	520	44.72	20.00	481	559
	2	5	1080	44.72	20.00	1041	1119

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
d^y	1	6	458	49.16	20.00	419	498
	2	6	1167	233.81	95.45	980	1354
g	1	6	583	103.28	42.16	501	666
	2	6	1150	236.64	96.60	961	1339
b	1	4	510	89.44	44.72	422	598
	2	4	1240	320.94	160.47	926	1555
S-Position C/——u							
d	1	8	469	37.20	13.15	443	495
	2	8	1081	277.67	98.17	889	1274
ḍ	1	2	550	70.71	50.00	452	648
	2	3	1100	173.21	100.00	904	1296
	3	1	2300	0.00			
ḏ	1	4	538	47.87	23.94	491	584
	2	4	1113	154.78	77.39	961	1264
d^y	1	10	480	91.89	29.06	423	537
	2	10	1210	128.67	40.68	1130	1290
g	1	37	516	70.76	11.63	493	539
	2	39	1087	225.57	36.12	1016	1158
b	1	13	462	68.17	18.90	424	499
	2	16	1044	156.92	39.23	967	1121

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
A-Position C/a——							
d	1	16	647	105.62	26.41	595	699
	2	16	1644	118.43	29.61	1586	1702
	3	3	2200	173.21	100.00	2004	2396
ḍ	1	18	567	76.70	18.08	531	602
	2	19	1676	125.13	28.70	1620	1733
	3	6	1867	206.56	84.33	1701	2032
$\underline{d}$	1	10	600	91.29	28.87	543	657
	2	10	1605	173.93	55.00	1497	1713
	3	1	2000	0.00			
d^{y}	1	9	511	78.17	26.06	460	562
	2	9	1778	237.32	79.11	1623	1933
g	1	15	607	106.68	27.54	553	661
	2	17	1391	150.24	36.44	1318	1463
b	1	18	586	131.51	31.00	525	647
	2	17	1312	183.31	44.46	1225	1399
A-Position C/——a							
d	1	18	545	99.85	23.53	499	591
	2	20	1693	162.44	36.32	1621	1764
	3	1	2200	0.00			
ḍ	1	11	562	76.79	23.15	516	607
	2	11	1643	154.24	46.50	1552	1734
	3	3	2000	100.00	57.74	1887	2113

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	upper
d̲	1	27	510	60.33	11.60	488	533
	2	28	1666	177.98	33.64	1600	1732
d^y	1	21	531	78.22	17.07	497	564
	2	20	1762	279.69	62.54	1639	1884
g	1	46	590	109.02	16.07	588	622
	2	47	1462	152.95	22.31	1418	1505
b	1	36	571	106.94	17.82	536	606
	2	35	1207	155.17	26.23	1156	1258
A-Positi n C/i——							
d	1	1	500	0.00			
	2	1	1800	0.00			
ḍ		ø					
d̲		ø					
d^y	1	7	436	37.80	14.29	408	464
	2	5	2083	116.90	52.28	1981	2186
g		ø					
b	1	2	425	35.36	25.00	376	474
	2	2	1800	282.84	200.00	1408	2192
A-Position C/——i							
d	1	4	525	50.00	25.00	476	574
	2	4	1925	309.57	154.79	1622	2228

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	95% confidence limits upper
ḍ	1	6	467	60.55	24.72	418	515
	2	8	1963	176.78	62.50	1840	2085
d̲	1	5	463	47.87	21.41	421	505
	2	5	1975	95.74	42.80	1891	2059
d^y	1	10	432	99.25	31.39	370	493
	2	6	2000	63.25	25.82	1949	2051
g	1	3	400	100.00	57.74	287	513
	2	3	1800	264.58	152.76	1501	2099
b	1	6	440	54.77	22.36	396	484
	2	7	1817	213.70	80.77	1658	1975
A-Position C/u—							
d	1	7	443	53.45	20.20	403	482
	2	7	1286	146.39	53.33	1177	1394
ḍ	1	2	500	0.00			
	2	2	1350	70.71	50.00	1252	1448
	3	1	1900	0.00			
d̲	1	5	490	54.77	24.49	442	538
	2	5	1440	181.66	81.24	1281	1599
d^y	1	6	417	75.25	30.72	356	477
	2	6	1233	216.02	88.19	1060	1406

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
g	1	6	583	129.10	52.70	480	687
	2	6	1058	228.95	93.47	875	1242
b	1	4	475	170.78	85.39	308	642
	2	4	1025	95.74	47.87	931	1119
A-Position C/—u							
d	1	8	456	49.55	17.52	422	491
	2	8	1394	154.54	54.64	1287	1501
ḍ	1	2	500	0.00			
	2	3	1533	152.75	88.19	1360	1706
	3	1	2000	0.00			
d̲	1	4	475	50.00	25.00	426	524
	2	4	1500	216.02	108.01	1288	1711
d^y	1	10	530	187.38	59.25	414	646
	2	10	1680	315.52	99.78	1484	1876
g	1	37	472	86.56	14.23	444	500
	2	39	986	160.14	25.64	936	1037
b	1	13	450	129.68	35.97	380	521
	2	16	975	131.19	32.80	911	1039

(B): Statistical Data of Nasals

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
S-Position C/a——							
n	1	7	746	71.44	27.00	693	799
	2	7	1571	157.86	59.67	1454	1688
ṇ	1	7	830	66.83	25.26	780	880
	2	7	1572	91.96	34.76	1504	1641
n̲	1	4	788	25.00	12.50	763	812
	2	4	1650	100.00	50.00	1552	1748
n^y	1	3	700	0.00			
	2	3	1800	0.00			
ŋ	1	3	808	88.75	51.24	707	908
	2	3	1648	89.49	51.67	1547	1750
m	1	7	740	51.27	19.38	702	778
	2	7	1583	100.09	37.83	1509	1652
S-Position C/——a							
n	1	16	763	111.66	27.92	708	818
	2	16	1565	137.26	34.32	1498	1633
ṇ	1	6	808	37.38	15.26	778	837
	2	6	1568	118.23	48.27	1473	1663
n̲	1	10	773	86.36	27.31	719	826
	2	10	1695	89.60	28.33	1639	1751
n^y	1	6	850	122.47	50.00	752	948
	2	6	1817	75.28	30.73	1756	1877

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
ŋ	1	4	800	81.65	40.82	720	880
	2	4	1638	110.87	55.43	1529	1746
m	1	8	779	100.59	35.56	710	849
	2	8	1525	116.50	41.19	1444	1606
S-Position C/i——							
n	1	7	443	53.45	20.20	403	482
	2	7	2100	100.00	37.80	2056	2174
ṇ	1	1	437	0.00			
	2	1	2046	0.00			
n̪	1	4	538	23.50	11.75	515	561
	2	4	2242	8.50	4.25	2237	2254
n^y		ϕ					
ŋ	1	1	450	0.00			
	2	1	2000	0.00			
m		ϕ					
S-Position C/——i							
n	1	1	500	0.00			
	2	1	2400	0.00			
ṇ	1	5	465	65.12	29.12	408	522
	2	5	2240	89.44	40.00	2162	2318

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
n̪		∅					
n^y	1	2	427	108.19	76.56	277	576
	2	2	2167	94.05	66.50	2036	2297
ŋ	1	2	475	35.36	25.00	426	524
	2	2	2000	0.00			
m	1	1	514	0.00			
	2	1	2136	0.00			
S-Position C/u——							
n	1	8	532	80.07	28.31	477	587
	2	8	1103	137.41	48.58	1008	1198
ṇ	1	3	450	0.00			
	2	3	1100	0.00			
n̪	1	2	531	43.84	31.00	470	592
	2	2	1152	72.83	51.50	1051	1252
n^y	1	6	600	0.00			
	2	6	1183	40.82	16.67	1151	1216
ŋ		∅					
m	1	2	575	176.78	125.00	330	820
	2	2	1100	0.00			
S-Position C/——u							
n	1	2	550	70.71	50.00	452	648
	2	2	1150	70.71	50.00	1052	1248

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
ṇ		ø					
n̲		ø					
n^y	1	4	550	57.74	28.87	493	607
	2	4	1150	57.74	28.87	1093	1207
ŋ	1	2	600	141.42	100.00	404	796
	2	2	1100	0.00			
m	1	4	482	35.50	17.75	447	517
	2	4	1021	178.29	89.15	846	1195
A-Position C/a——							
n	1	7	454	41.90	15.84	423	485
	2	7	1500	81.65	30.86	1440	1560
ṇ	1	6	521	116.64	47.62	428	614
	2	6	1658	168.57	68.82	1523	1793
n̲	1	4	550	100.00	50.00	452	648
	2	4	1575	132.29	66.14	1445	1705
n^y	1	3	633	115.47	66.67	503	764
	2	1	2000	0.00			
ŋ	1	3	550	100.00	57.74	437	663
	2	1	1375	0.00			
m	1	6	542	146.34	59.74	425	659
	2	6	1233	132.92	54.26	1127	1337

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
A-Position C/——a							
n	1	13	494	83.01	23.02	449	539
	2	16	1522	182.32	45.58	1433	1611
ṇ	1	5	500	117.26	52.44	397	603
	2	6	1675	189.08	77.19	1524	1826
n̪	1	8	531	106.70	37.72	457	605
	2	9	1639	126.93	42.31	1556	1722
n^y	1	6	550	148.32	60.55	431	669
	2	4	2213	25.00	37.50	2139	2286
ŋ	1	3	467	28.87	16.67	434	499
	2	3	1483	104.08	60.09	1366	1601
m	1	5	530	144.05	64.42	404	656
	2	8	1263	188.51	66.65	1132	1393
A-Position C/i——							
n	1	7	468	74.60	28.20	413	523
	2	6	1583	213.70	87.24	1412	1754
ṇ	1	1	500	0.00			
	2	1	1900	0.00			
n̪	1	1	700	0.00			
	2	4	1738	47.87	23.94	1691	1785

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
n^y		ø					
ŋ	1	1	750	0.00			
	2	1	1250	0.00			
m		ø					
Λ-Position C/——i							
n	1	1	500	0.00			
	2	1	1500	0.00			
ṇ	1	5	515	65.19	29.15	458	572
	2	4	1850	57.74	28.87	1793	1907
n̲		ø					
n^y	1	2	550	70.71	50.00	452	648
	2	2	2000	0.00			
ŋ	1	2	625	176.78	125.00	380	870
	2	2	1325	106.07	75.00	1178	1472
m	1	1	750	0.00			
	2	ø					
Λ-Position C/u——							
n	1	6	508	115.83	47.29	416	601
	2	8	1456	158.54	56.05	1346	1566
ṇ	1	3	483	28.87	16.67	451	516
	2	3	1867	57.74	33.33	1801	1932

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
n̲	1	2	550	70.71	50.00	452	648
	2	2	1550	353.55	250.00	1060	2040
n^y	1	6	540	54.77	24.49	492	588
	2	6	2175	199.37	81.39	2015	2335
ŋ		ϕ					
m	1	1	500	0.00			
	2	2	1475	106.07	75.00	1328	1622
A-Position C/——u							
n	1	2	400	0.00			
	2	2	1450	141.42	100.00	1254	1646
ṇ		ϕ					
n̲		ϕ					
n^y	1	4	550	57.74	28.87	493	607
	2	4	2150	288.68	144.34	1867	2433
ŋ	1	2	675	35.36	25.00	626	724
	2	1	1200	0.00			
m	1	3	567	115.47	66.67	436	697
	2	4	1331	68.84	34.42	1264	1399

(C): Statistical Data of Laterals

S-Position C/a——							
[illegible]	1	6	787	76.59	31.29	725	848
	2	6	1571	195.30	79.73	1414	1727

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	95% confidence limits upper
[illegible]	1	5	791	53.38	23.87	745	838
	2	5	1529	41.18	18.42	1493	1566
[illegible]	1	3	690	77.94	45.00	602	778
	2	3	1556	48.50	28.00	1501	1611
[illegible]^{y}	1	5	797	58.81	26.30	746	849
	2	5	1565	86.00	38.46	1489	1640
S-Position C/——a							
[illegible]	1	5	800	70.71	31.62	738	862
	2	5	1670	156.52	70.00	1533	1807
[illegible]	1	7	791	85.16	32.19	728	854
	2	7	1572	124.99	47.24	1479	1665
[illegible]	1	8	718	47.83	16.91	685	752
	2	8	1541	67.47	23.85	1494	1588
[illegible]^{y}	1	4	734	68.50	34.25	667	801
	2	4	1606	136.18	68.09	1473	1739
S-Position C/i——							
[illegible]	1	4	475	50.00	25.00	426	524
	2	4	2131	143.43	71.72	1991	2772
[illegible]	1	1	400	0.00			
	2	1	2000	0.00			
[illegible]	1	4	478	81.50	40.75	398	558
	2	4	2035	23.00	11.50	2012	2057

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
[illegible]^{y}	1	2	468	0.00			
	2	2	2100	0.00			
S-Position C/——i							
[illegible]	1	1	500	0.00			
	2	1	2000	0.00			
[illegible]	1	3	467	57.74	33.33	401	532
	2	3	2133	152.75	88.19	1960	2306
[illegible]		ø					
[illegible]^{y}	1	3	458	17.90	10.33	437	478
	2	3	2095	42.72	27.64	2047	2144
S-Position C/[illegible] ——							
[illegible]	1	5	533	62.11	27.78	478	587
	2	5	1012	86.25	38.57	936	1087
[illegible]	1	5	477	43.63	19.51	439	516
	2	5	1091	83.56	37.37	1018	1164
[illegible]	1	2	400	0.00			
	2	2	1200	0.00			
[illegible]^{y}	1	2	513	52.33	37.00	440	586
	2	2	1196	76.37	54.00	1090	1302

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
S-Position C/——u							
[illegible]	1	5	487	21.65	9.68	468	506
	2	5	1063	50.48	22.57	1019	1108
[illegible]	1	3	491	7.51	4.33	483	500
	2	3	1057	69.86	40.33	978	1136
[illegible]		ø					
[illegible]^y	1	1	500	0.00			
	2	1	1200	0.00			
A-Position C/a——							
[illegible]	1	6	471	51.03	20.83	430	512
	2	3	1533	152.75	88.19	1360	1706
[illegible]	1	5	430	64.71	28.94	373	487
	2	3	1608	150.69	87.00	1438	1779
[illegible]	1	3	467	28.87	16.67	434	499
	2	3	1600	264.58	152.75	1301	1899
[illegible]^y	1	5	440	51.84	23.18	395	485
	2	5	1944	196.19	98.09	1751	2136
A-Position C/——a							
[illegible]	1	5	475	55.90	25.00	426	524
	2	3	1533	57.74	33.33	1468	1599

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	95% confidence limits upper
[illegible]	1	7	488	85.91	32.47	424	551
	2	6	1446	105.38	43.02	1362	1530
[illegible]	1	8	453	39.39	13.93	426	480
	2	7	1639	171.91	64.98	1512	1767
[illegible]^y	1	4	444	51.54	25.77	393	494
	2	4	1906	168.79	84.39	1741	2072
A-Position C/i——							
[illegible]	1	4	500	0.00			
	2	4	1580	242.76	121.38	1342	1818
[illegible]	1	1	500	0.00			
	2	1	1650	0.00			
[illegible]	1	4	488	47.87	23.94	441	534
	2	4	1700	100.00	50.00	1602	1798
[illegible]^y	1	2	638	17.68	12.50	613	662
	2	1	2050	0.00			
A-Position C/——i							
[illegible]	1	1	500	0.00			
	2	1	1500	0.00			
[illegible]	1	3	442	62.92	36.32	370	513
	2	3	1592	194.19	112.11	1372	1811
[illegible]		ø					

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
ε^y	1	3	592	80.36	46.40	501	683
	2	2	2025	35.36	25.00	1976	2074
A-Position C/u——							
ε	1	5	480	44.72	20.00	441	519
	2	5	1370	59.27	26.51	1318	1422
ε:	1	5	450	93.54	41.83	368	532
	2	5	1410	135.36	60.52	1291	1529
$\underline{\varepsilon}$	1	2	412	54.45	38.50	336	487
	2	1	1625	0.00			
ε^y	1	2	475	35.36	25.00	426	524
	2	2	1975	35.36	25.00	1926	2024
A-Positior C/——u							
ε	1	5	480	44.72	20.00	441	519
	2	5	1370	59.27	26.51	1318	1422
ε:	1	3	458	87.80	50.69	386	585
	2	3	1425	188.75	106.97	1211	1639
$\underline{\varepsilon}$		∅					
ε^y	1	1	475	0.00			
	2	1	2100	0.00			

APPENDIX 7:

(A) Statistical Data of Vowels.

(B) $F_2 \times F_1$ representation of the 95% confidence limits and mean values of vowels for each language.

(Formant values are to the nearest whole number)

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
YANYULA							
i	1	7	514	24.40	9.22	496	532
	2	7	2136	102.93	38.90	2059	2212
a	1	20	723	69.73	15.59	692	753
	2	20	1545	74.16	16.58	1513	1578
a:	1	1	800	0.00			
	2	1	1650	0.00			
u	1	1	500	0.00			
	2	2	1100	141.42	100.00	904	1296
u:	1	1	550	0.00			
	2	1	1250	0.00			
MARA							
i	1	11	614	128.12	38.63	538	690
	2	11	1532	225.30	67.93	1399	1665
a	1	14	820	93.63	25.02	771	869
	2	14	1524	132.54	35.42	1454	1593
u	1	16	550	88.51	22.13	507	594
	2	16	1419	203.20	50.80	1319	1518
KUUKU-YA?U							
i	1	1	350	0.00			
	2	1	2100	0.00			
a	1	7	743	73.19	27.66	689	797
	2	7	1479	128.64	48.62	1383	1574

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
u	1	8	431	51.32	18.15	396	467
	2	8	975	103.51	36.60	903	1047
u:	1	1	375	0.00			
	2	1	950	0.00			
DJINGILI							
i	1	11	468	92.93	28.02	413	523
	2	11	2127	132.97	40.09	2049	2206
a	1	18	825	80.90	19.07	788	862
	2	18	1497	60.57	14.28	1469	1525
u	1	10	423	29.93	9.46	404	441
	2	10	1010	56.76	17.95	975	1045
YUKULTA							
i	1	1	500	0.00			
	2	1	2300	0.00			
a	1	19	824	80.14	18.38	788	860
	2	19	1738	125.38	28.76	1682	1795
a:	1	2	750	0.00			
	2	2	1550	70.71	50.00	1452	1848
u	1	6	429	45.87	18.73	392	466
	2	6	783	112.55	45.93	693	873
u:	1	1	500	0.00			
	2	1	1100	0.00			

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	95% confidence limits upper
PITJANTJATJARA							
i	1	4	488	25.00	12.50	463	512
	2	4	2050	57.74	28.87	1993	2107
a	1	28	837	71.02	13.42	811	863
	2	28	1524	88.83	16.79	1491	1556
u	1	15	487	29.68	7.66	472	502
	2	15	1017	58.76	15.17	987	1046
DJAMBARRPUYNGU							
i	1	3	483	28.87	16.67	451	516
	2	3	1900	100.00	57.74	1787	2013
a	1	12	717	24.62	7.11	703	731
	2	16	1509	141.97	35.49	1440	1579
a:	1	4	713	143.61	71.81	512	853
	2	4	1625	104.08	52.04	1523	1727
u	1	6	500	104.58	42.82	416	584
	2	6	838	220.09	89.85	661	1014
u:	1	5	425	50.00	22.36	381	469
	2	5	1110	89.44	40.00	1032	1188
ARABANA							
i	1	15	503	48.06	12.41	491	528
	2	15	2233	166.55	43.00	2149	2318
a	1	24	848	105.79	21.59	806	890
	2	24	1675	95.55	19.50	1637	1713

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
u	1	16	563	59.16	14.79	534	591
	2	16	1203	117.57	29.39	1146	1261
WARAMUNGA							
i	1	11	505	26.97	8.13	489	520
	2	12	2025	121.54	35.09	1956	2094
a	1	13	777	90.41	25.07	728	826
	2	16	1625	91.29	22.82	1580	1670
u	1	13	500	35.36	9.81	481	519
	2	13	1138	150.21	41.66	1057	1220
DIYARI							
i	1	13	473	38.81	10.76	452	494
	2	13	2046	112.66	31.25	1985	2107
a	1	41	735	110.82	17.31	701	769
	2	41	1584	95.49	14.91	1554	1613
u	1	13	477	48.37	13.42	451	503
	2	13	1142	99.68	27.65	1088	1197
YANDRUWANDHA							
i	1	2	500	0.00			
	2	2	2400	141.42	100.00	2204	2596
a	1	14	721	77.74	20.78	681	762
	2	14	1525	123.65	33.05	1460	1590
u	1	3	492	112.73	65.09	364	619
	2	3	1000	0.00			

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
YATHAIKANA							
i	1	4	550	173.21	86.60	380	720
	2	1	2250	0.00			
e	1	1	750	0.00			
	2	1	1600	0.00			
a	1	25	826	89.12	17.82	791	861
	2	25	1591	144.25	28.85	1534	1648
a:	1	7	821	144.65	54.67	714	929
	2	7	1621	80.92	30.58	1561	1681
u	1	11	509	104.45	31.49	447	571
	2	11	1045	129.33	39.00	969	1122
u:	1	1	400	0.00			
	2	1	600	0.00			
WIK-EP							
i:	1	1	550	0.00			
	2	1	2000	0.00			
e	1	1	750	0.00			
	2	1	1950	0.00			
e:	1	1	850	0.00			
	2	1	2000	0.00			
a	1	19	850	102.74	23.57	804	896
	2	19	1611	85.92	19.71	1572	1649
a:	1	6	863	115.92	47.32	770	455
	2	6	1600	63.25	25.82	1549	1651

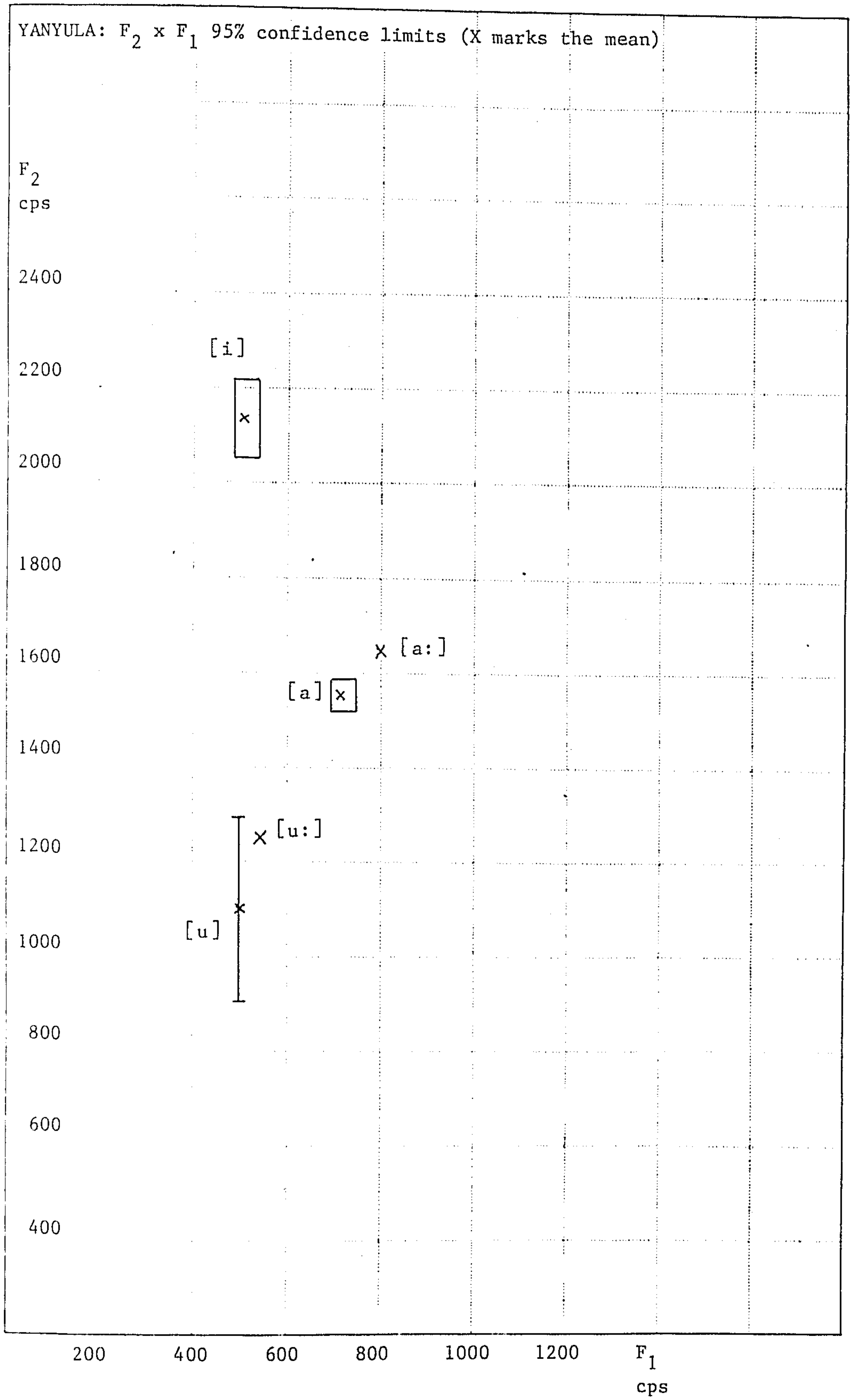
Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
o:	1	2	725	35.36	25.00	676	774
	2	2	1225	35.36	25.00	1176	1274
u	1	4	563	47.87	23.94	516	609
	2	4	1163	149.30	74.65	1016	1309
u:	1	1	500	0.00			
	2	1	1000	0.00			
ə	1	2	725	35.36	25.00	676	774
	2	2	1875	35.36	25.00	1826	1924
ö	1	3	608	101.04	58.33	494	723
	2	2	1500	0.00			
ü	1	1	500	0.00			
	2	1	1375	0.00			

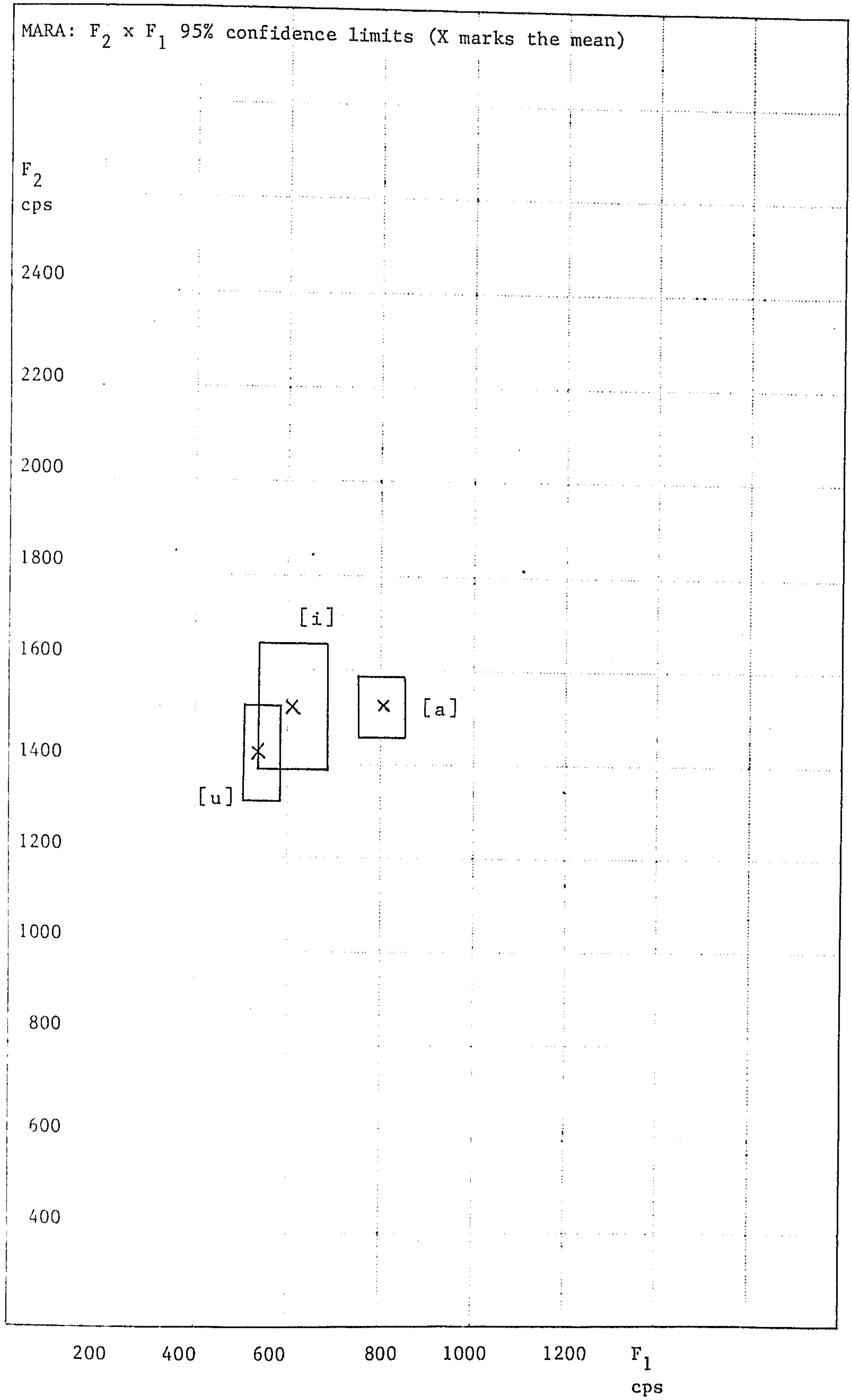
WIKMUNKAN

Segment	Formant	n	$\bar{x}$	s.d.	S.E.	lower	upper
i	1	2	425	35.36	25.00	376	474
	2	2	2275	106.67	75.00	2128	2422
e	1	4	613	85.39	42.70	529	696
	2	4	1925	50.00	25.00	1876	1974
e:	1	1	500	0.00			
	2	1	1700	0.00			
a	1	15	785	87.09	22.49	741	829
	2	15	1670	70.20	18.13	1634	1706
a:	1	7	857	97.59	36.89	785	929
	2	7	1647	84.99	32.12	1584	1710
o	1	2	525	35.36	25.00	476	574
	2	3	1300	100.00	57.74	1187	1413

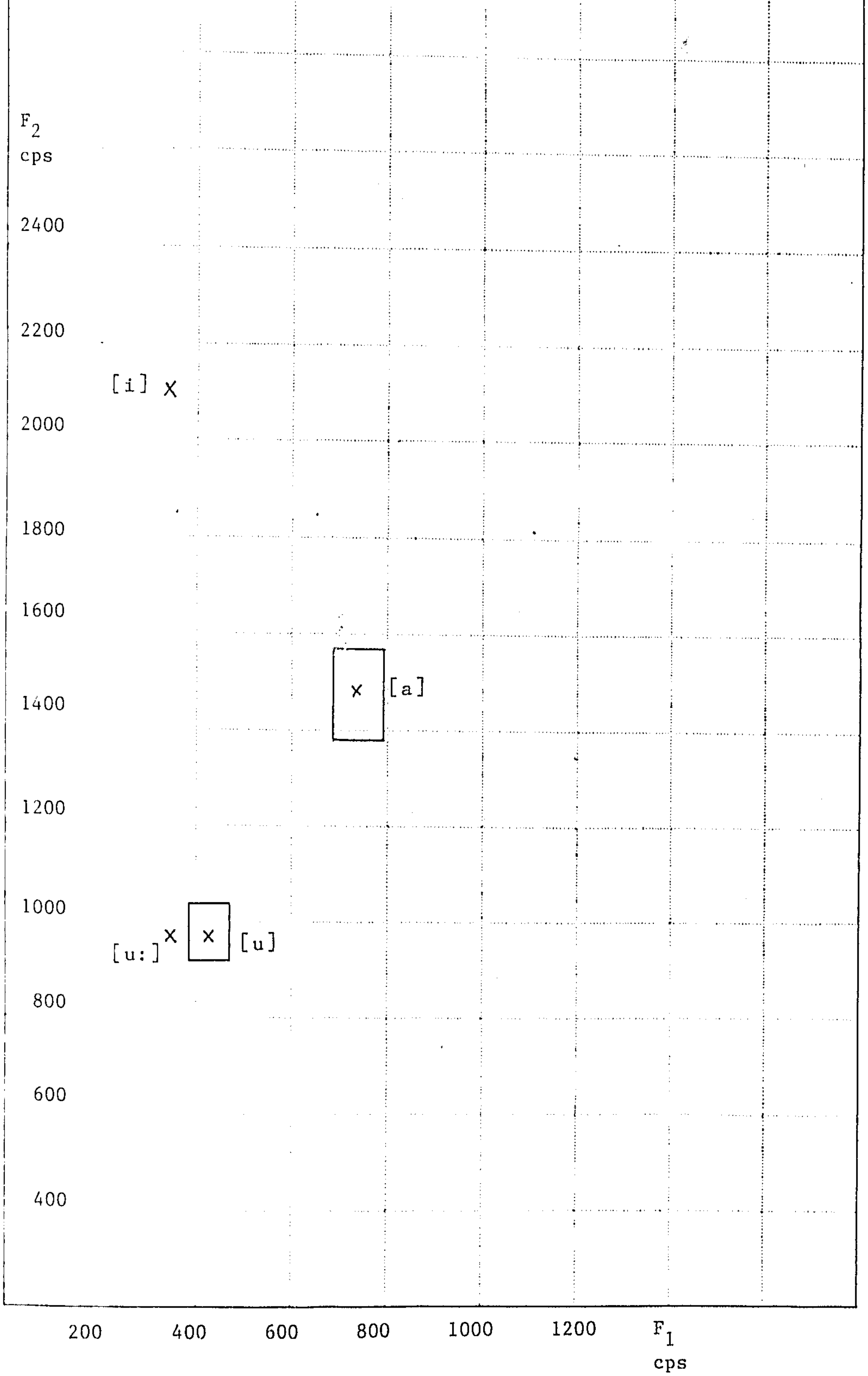
Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits	
						lower	upper
o:	1	1	650	0.00			
	2	1	1250	0.00			
u	1	2	500	0.00			
	2	2	1150	70.71	50.00	1052	1248
ə	1	7	617	74.55	28.18	562	672
	2	7	1729	69.86	26.41	1677	1780
MPAKWITHI							
a	1	12	746	172.49	49.79	648	843
	2	12	1463	201.27	58.10	1349	1576
ɔ	1	3	500	0.00			
	2	3	1210	36.06	20.82	1169	1251
u	1	4	394	12.50	6.25	382	406
	2	4	963	149.30	74.65	816	1109
URTJAR							
e	1	5	600	61.24	27.39	546	654
	2	5	1840	96.18	43.01	1756	1924
a	1	5	790	124.50	55.68	681	899
	2	5	1530	44.72	20.00	1491	1569
a:	1	2	1000	0.00			
	2	2	1775	35.36	25.00	1726	1824
o	1	8	565	38.91	13.76	538	592
	2	8	1094	120.82	42.72	1010	1177
ɨ	1	5	710	143.18	64.03	585	836
	2	5	1710	224.72	100.50	1513	1907

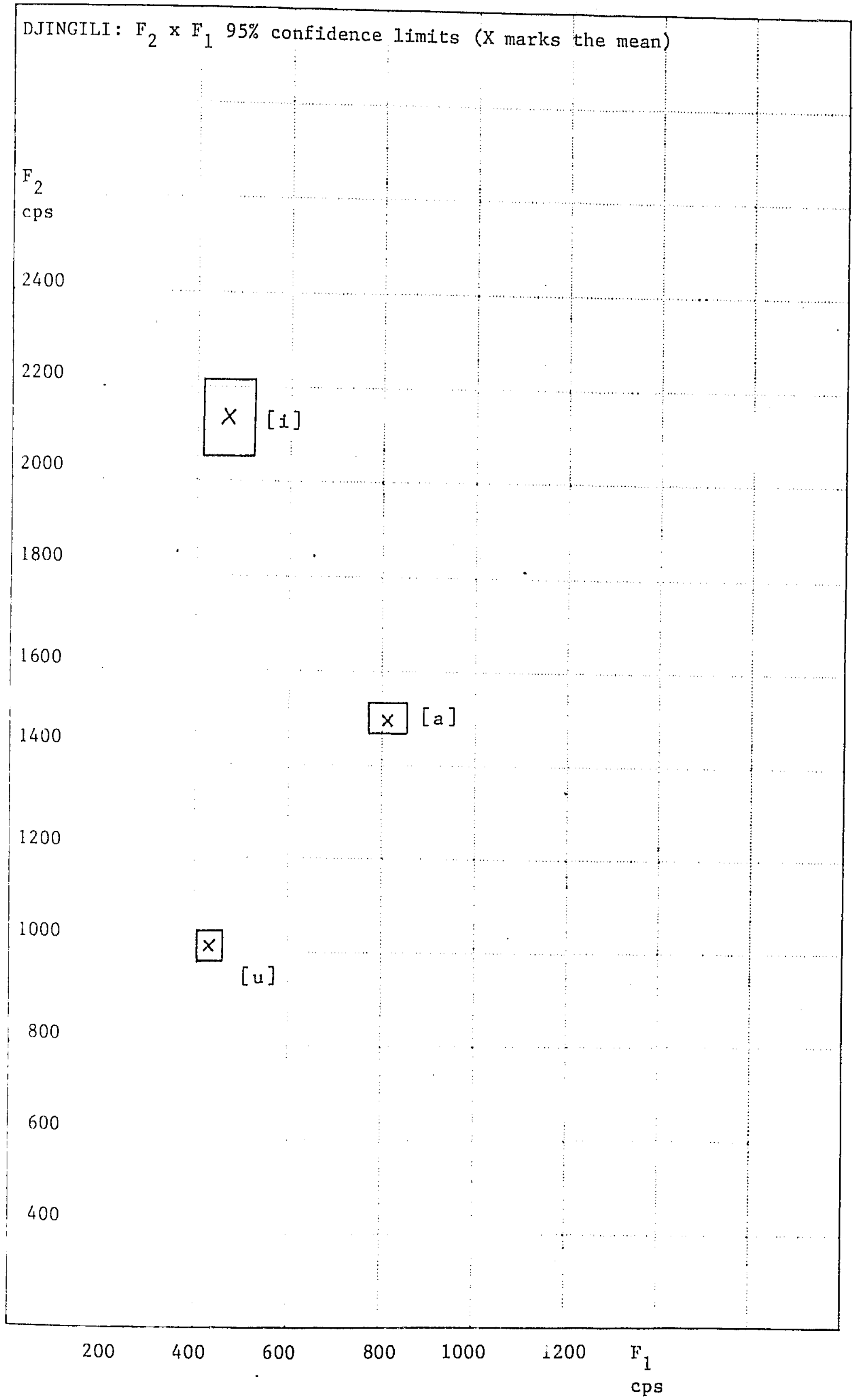
Segment	Formant	n	$\bar{x}$	s.d.	S.E.	95% confidence limits lower	95% confidence limits upper
ö	1	1	600	0.00			
	2	1	1300	0.00			
KAITITJ							
i	1	2	650	70.71	50.00	552	748
	2	2	1550	70.71	50.00	1452	1648
a	1	7	736	106.90	40.41	657	815
	2	7	1504	177.03	66.91	1372	1635
o	1	2	550	70.71	50.00	452	648
	2	2	1300	141.42	100.00	1104	1496
u	1	1	400	0.00			
	2	1	1200	0.00			
ə	1	1	500	0.00			
	2	1	1200	0.00			
ɨ	1	1	400	0.00			
	2	1	1500	0.00			
MURINBATA							
i	1	2	500	0.00			
	2	2	1950	70.71	50.00	1852	2048
e	1	13	550	64.55	17.40	515	585
	2	13	1696	139.14	38.59	1621	1772
a	1	21	702	73.27	15.99	671	734
	2	21	1507	97.83	21.35	1465	1549
u	1	13	515	55.47	15.38	485	546
	2	13	1254	126.59	35.11	1185	1323

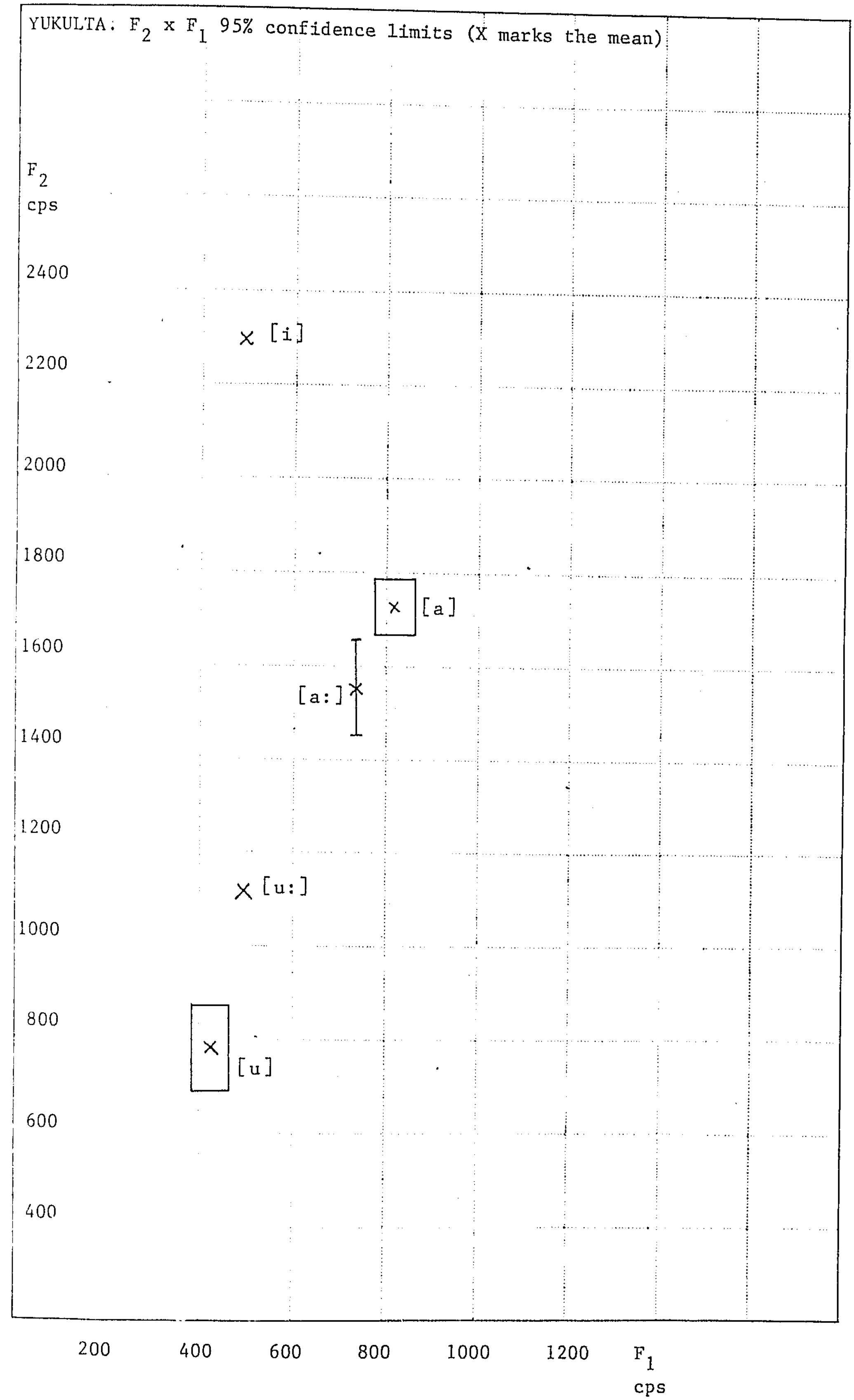

YANYULA: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a:]
[a]
[u:]
[u]
200
400
600
800
1000
1200
F1
cps

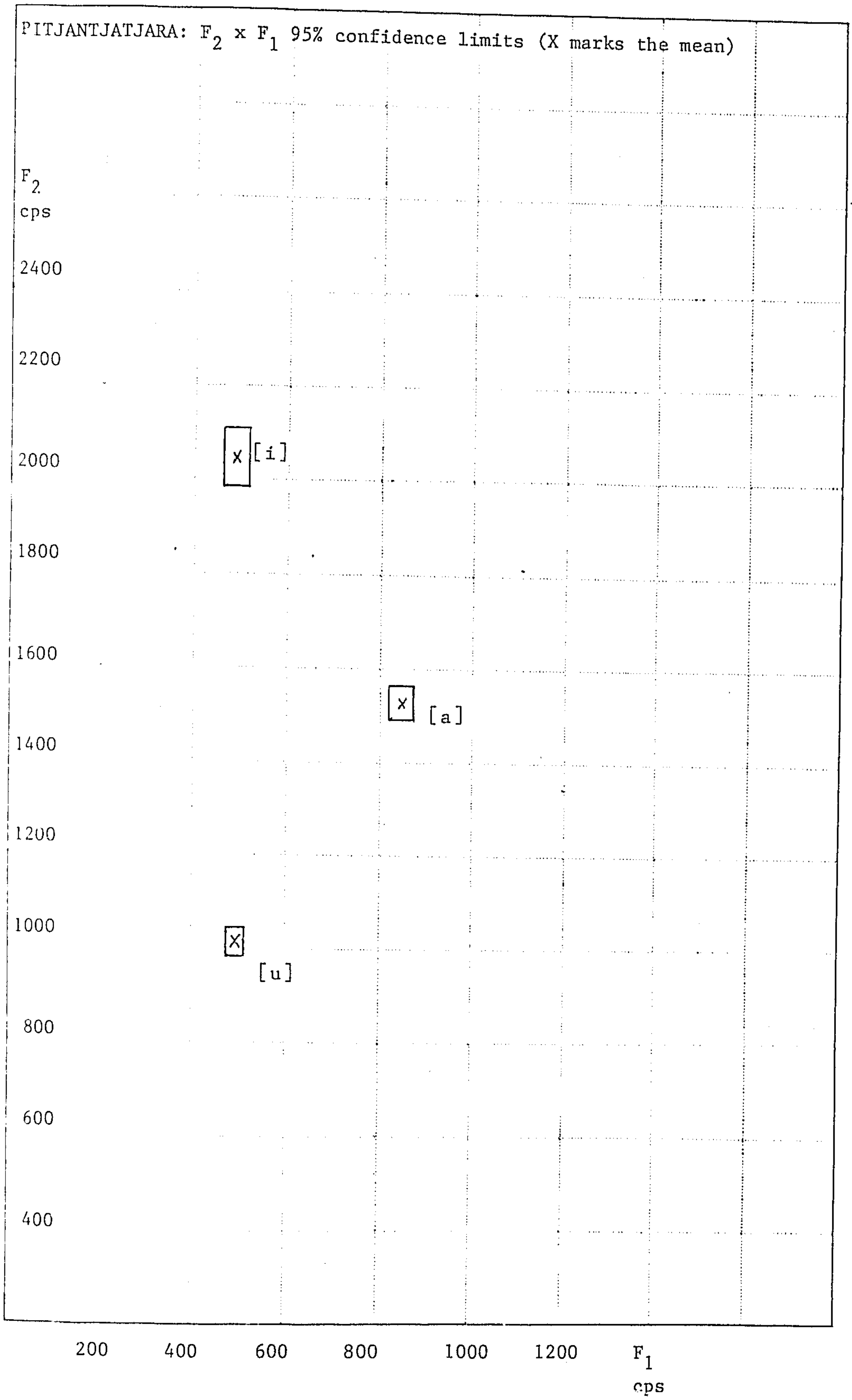

MARA: F_2 x F_1 95% confidence limits (X marks the mean)
F_2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[u]
200
400
600
800
1000
1200
F_1
cps

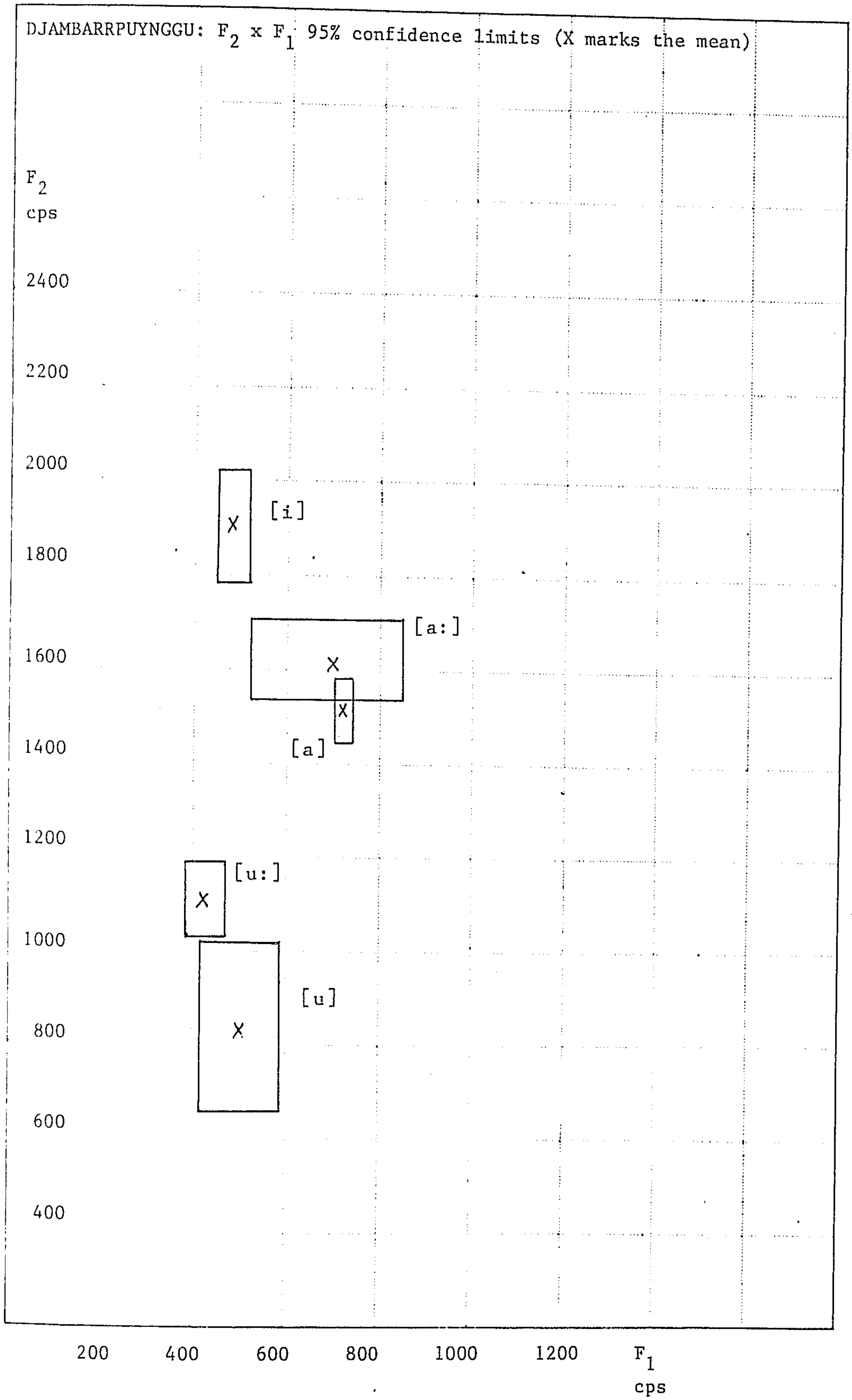
KUUKU-YA?U: $F_2 \times F_1$ 95% confidence limits (X marks the mean)

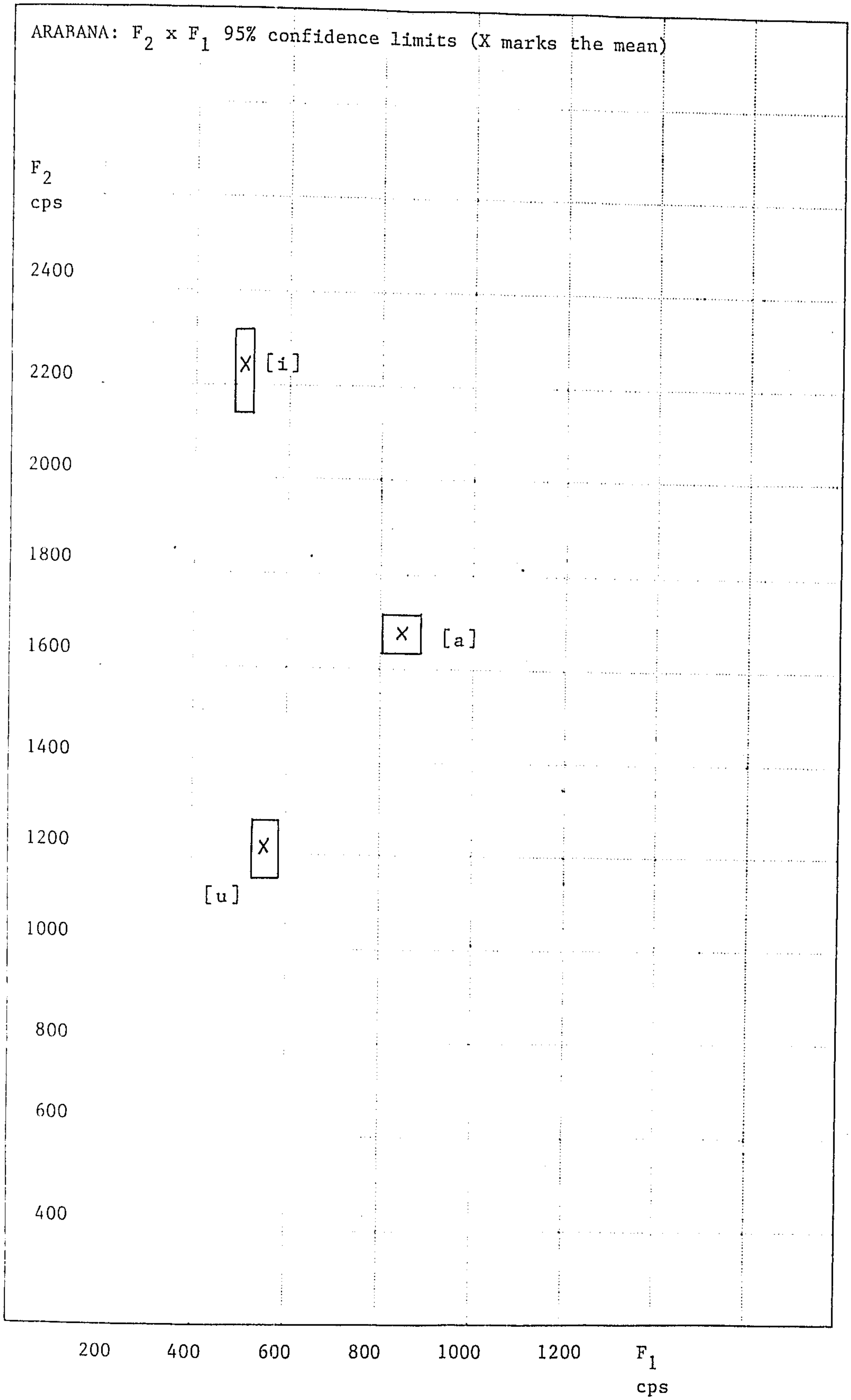


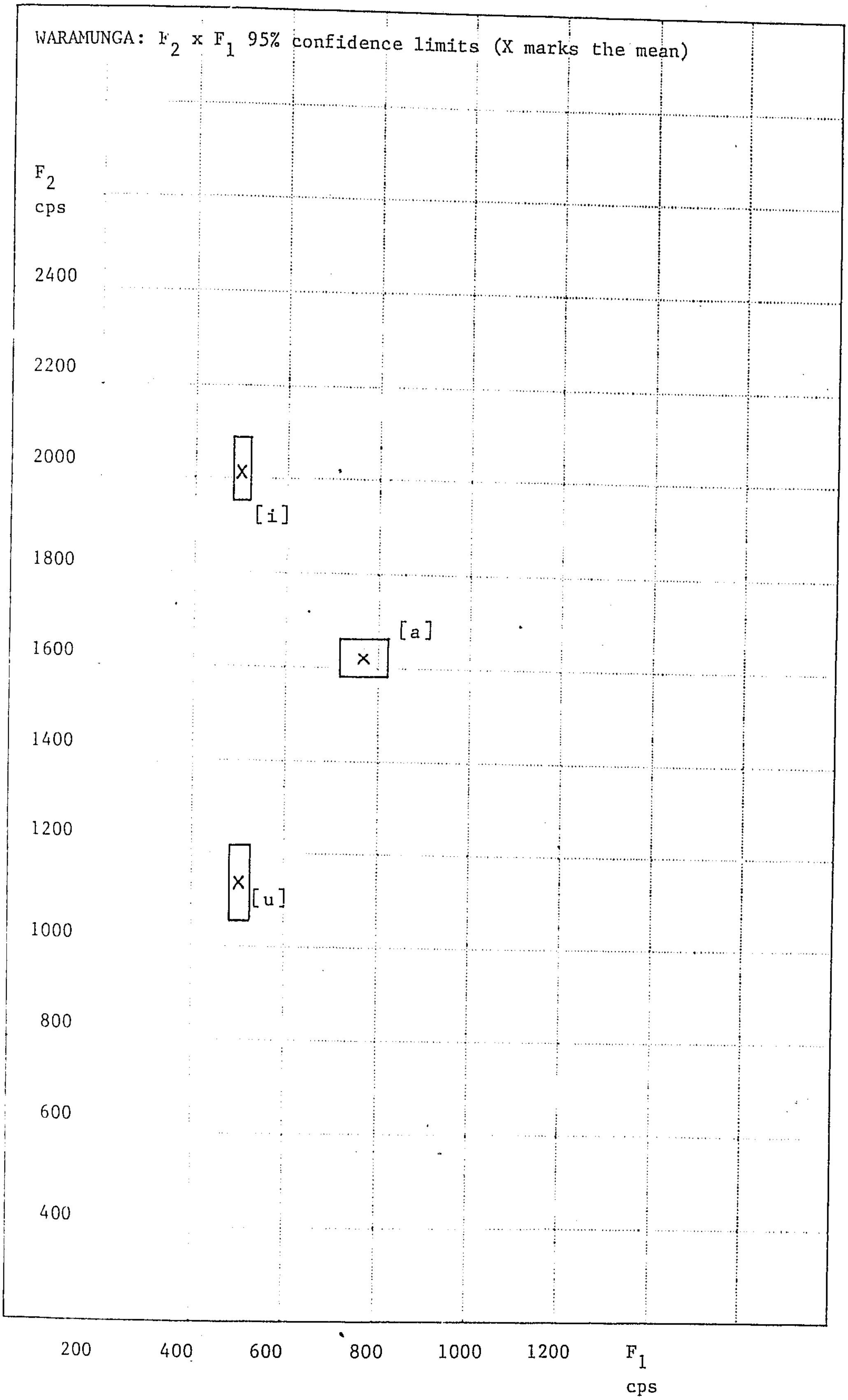

DJINGILI: F_2 x F_1 95% confidence limits (X marks the mean)
F_2 cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[u]
200
400
600
800
1000
1200
F_1 cps

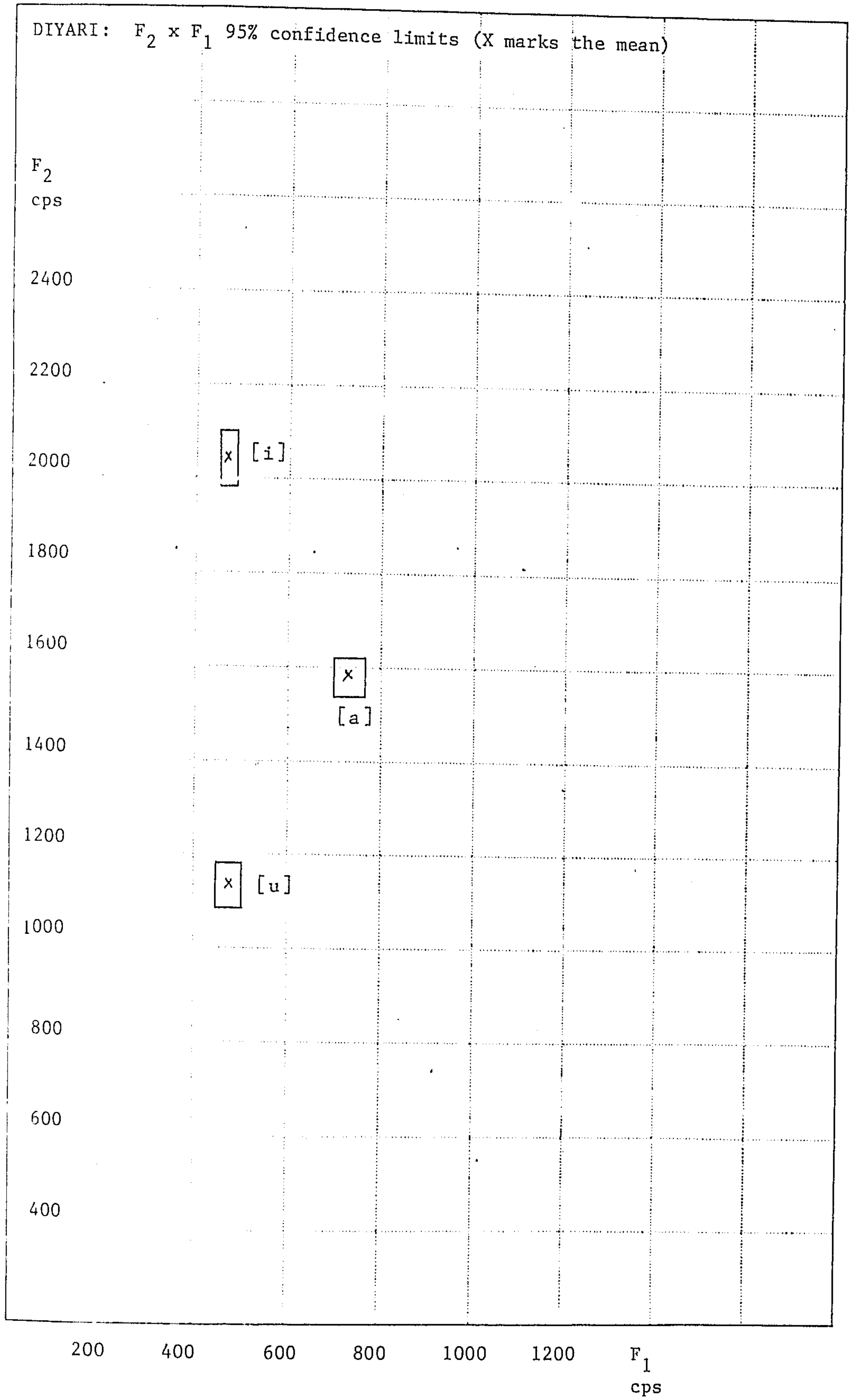

YUKULTA: F_2 x F_1 95% confidence limits (X marks the mean)
F_2 cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[a:]
[u:]
[u]
200
400
600
800
1000
1200
F_1 cps

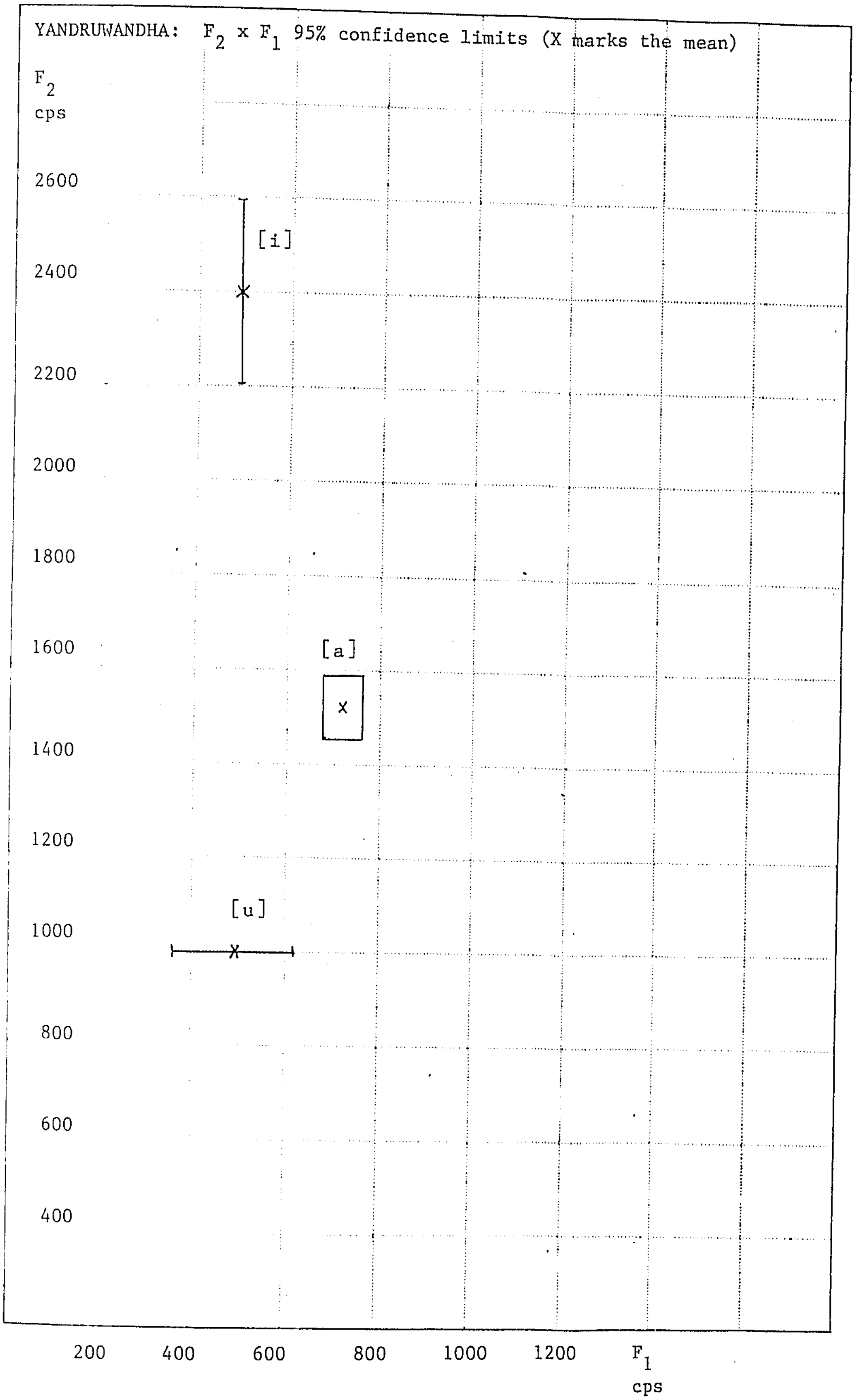

PITJANTJATJARA: $F_2 \times F_1$ 95% confidence limits (X marks the mean)
F_2 cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[u]
200
400
600
800
1000
1200
F_1 cps

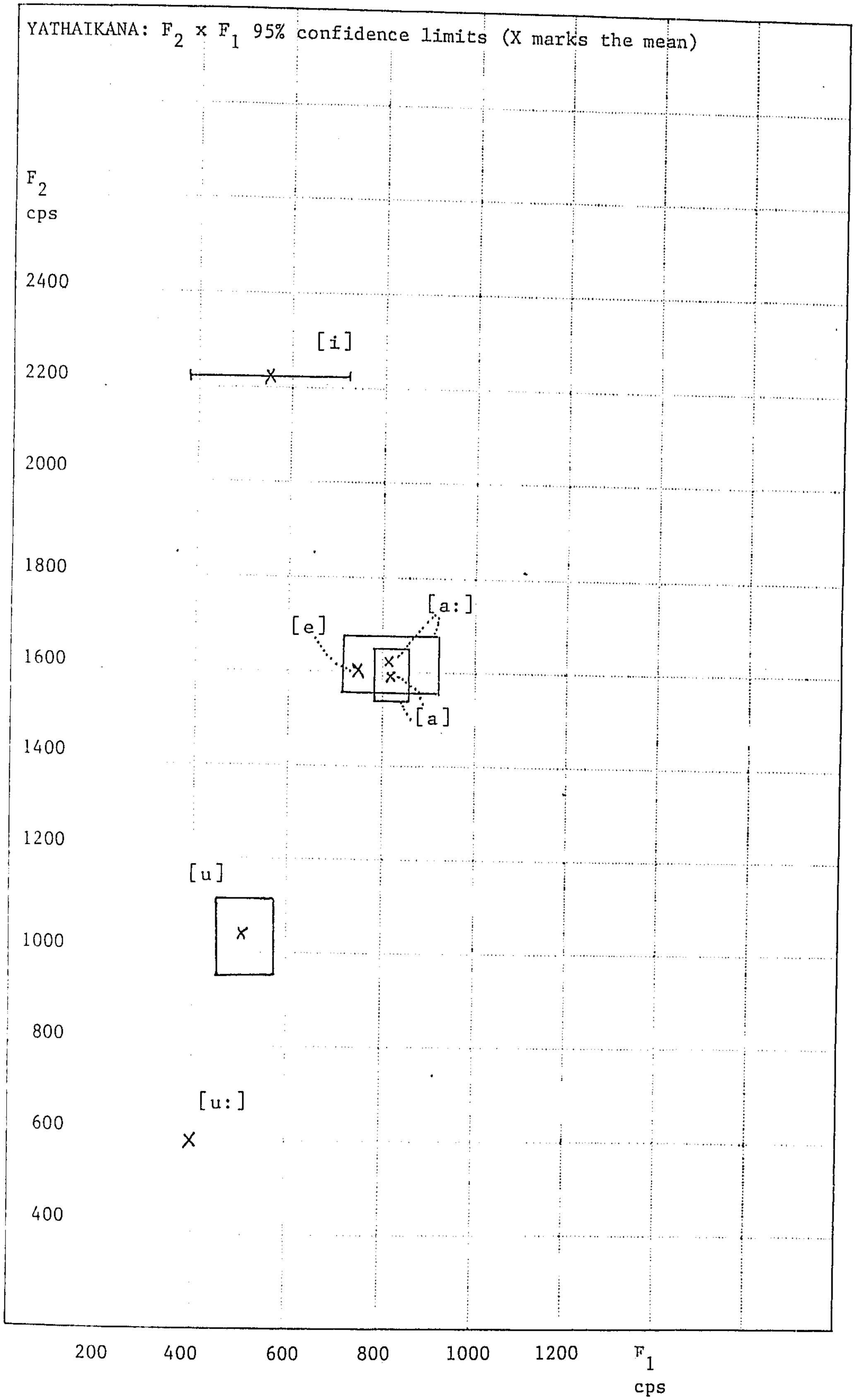

DJAMBARRPUYNGGU: F_2 x F_1 95% confidence limits (X marks the mean)
F_2 cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a:]
[a]
[u:]
[u]
X
200
400
600
800
1000
1200
F_1 cps

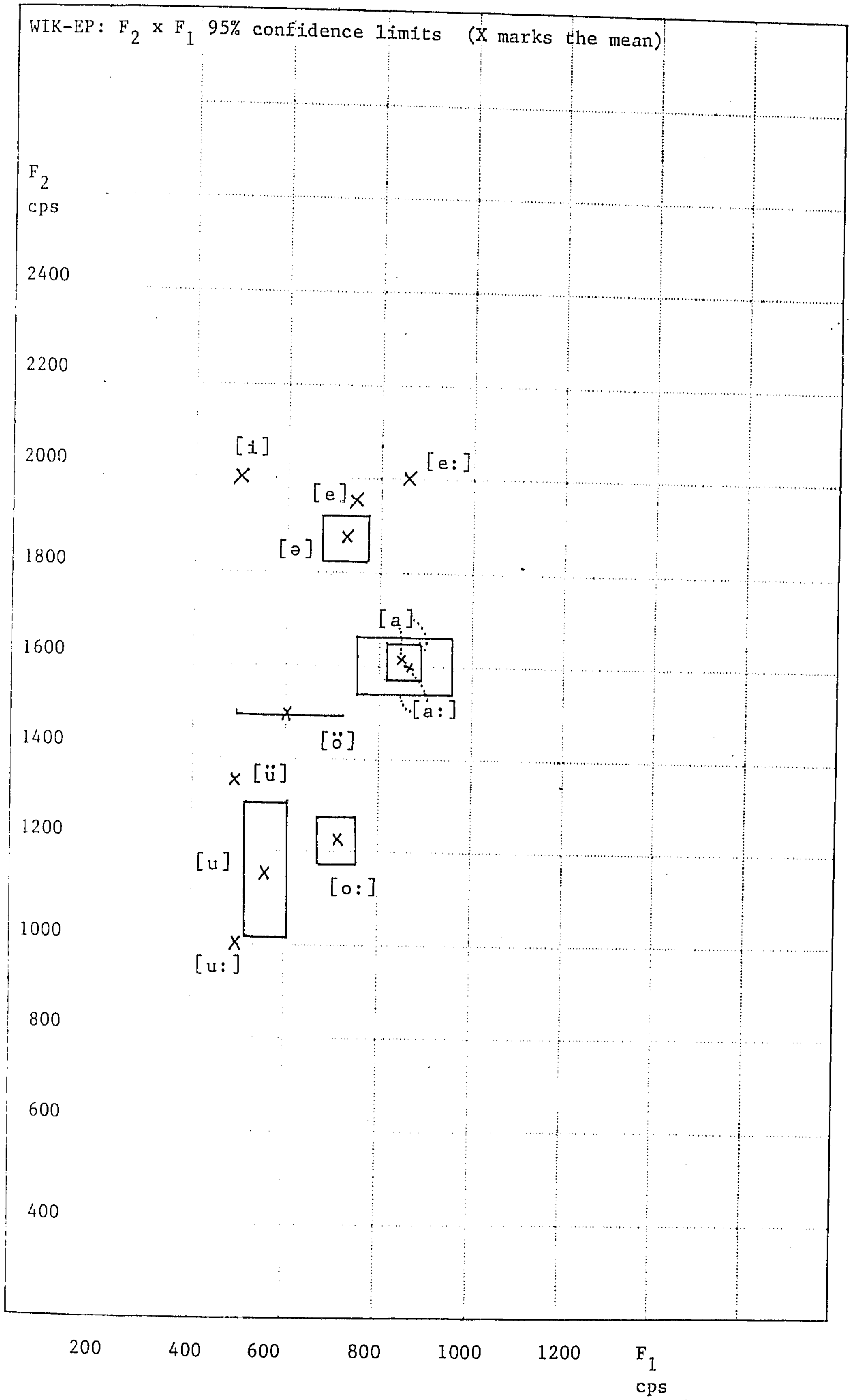

ARABANA: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
X
[i]
X
[a]
X
[u]
200
400
600
800
1000
1200
F1
cps


WARAMUNGA: $F_2 \times F_1$ 95% confidence limits (X marks the mean)
F_2 cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[u]
200
400
600
800
1000
1200
F_1 cps


DIYARI: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
x
[i]
x
[a]
x
[u]
200
400
600
800
1000
1200
F1
cps


YANDRUWANDHA: F_2 x F_1 95% confidence limits (X marks the mean)
F_2
cps
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[a]
[u]
200
400
600
800
1000
1200
F_1
cps


YATHAIKANA: F_2 x F_1 95% confidence limits (X marks the mean)
F_2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[e]
[a:]
[a]
[u]
[u:]
200
400
600
800
1000
1200
F_1
cps


WIK-EP: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[e:]
[e]
[ə]
[a]
[a:]
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[o:]
[u:]
200
400
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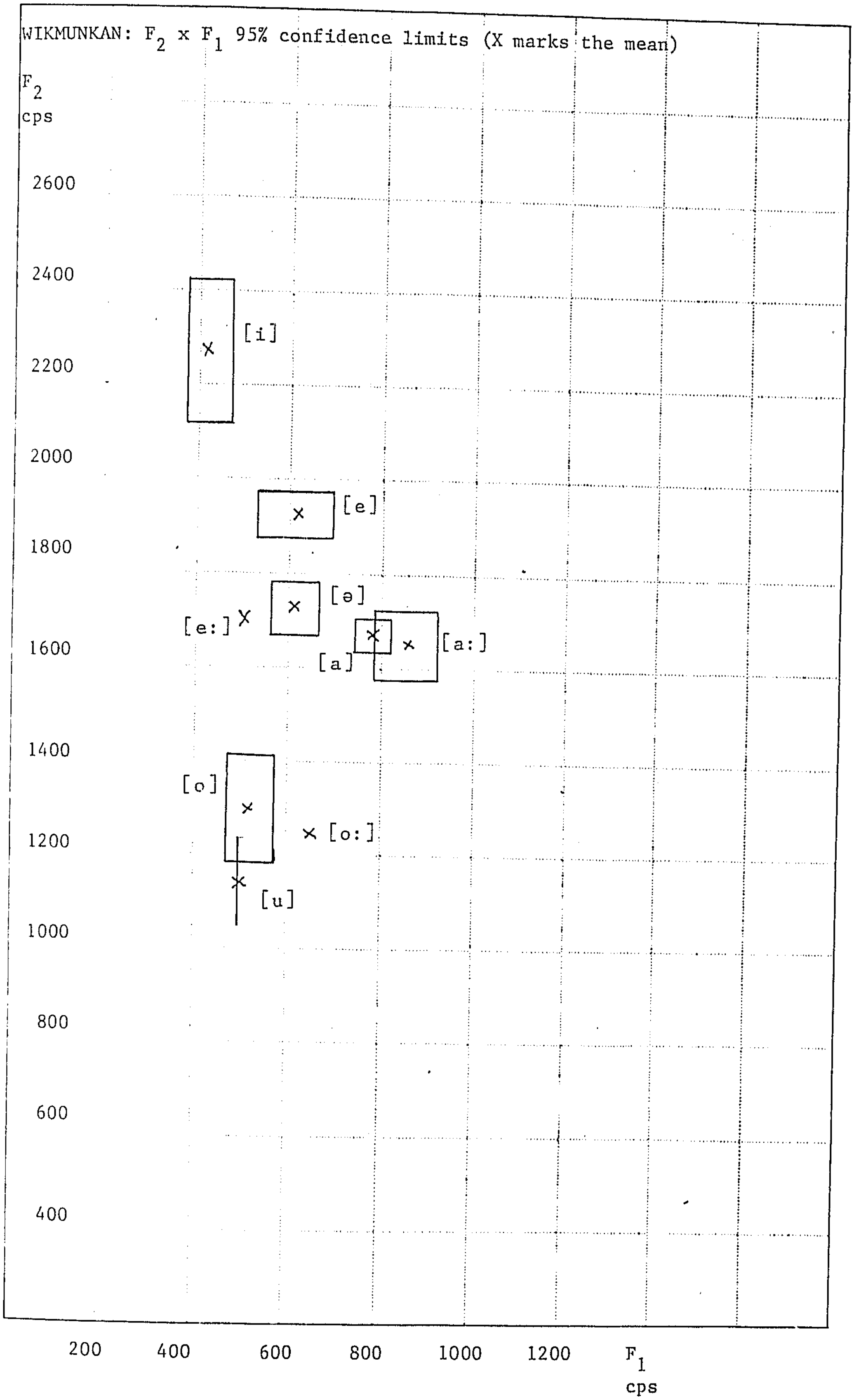
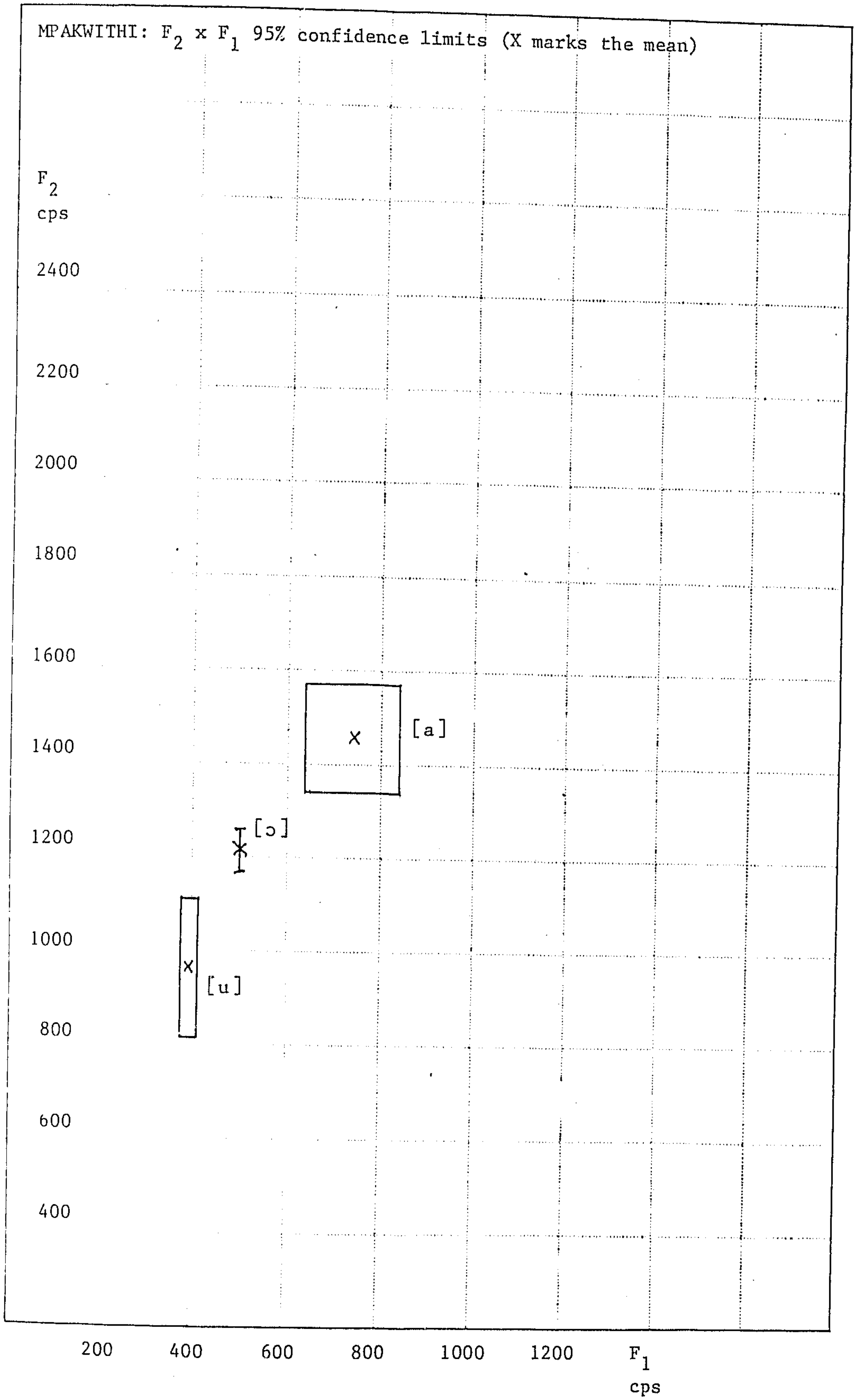
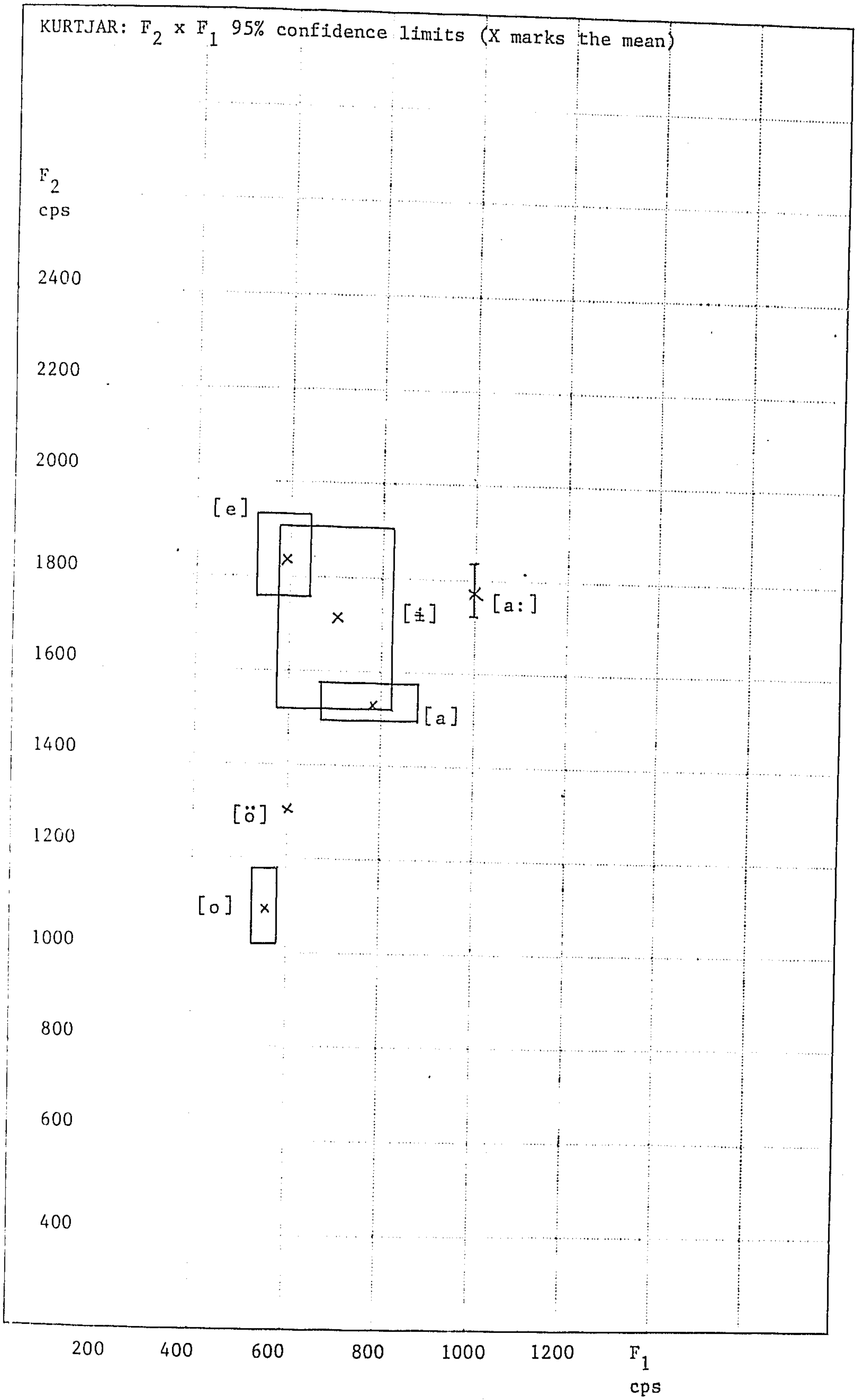
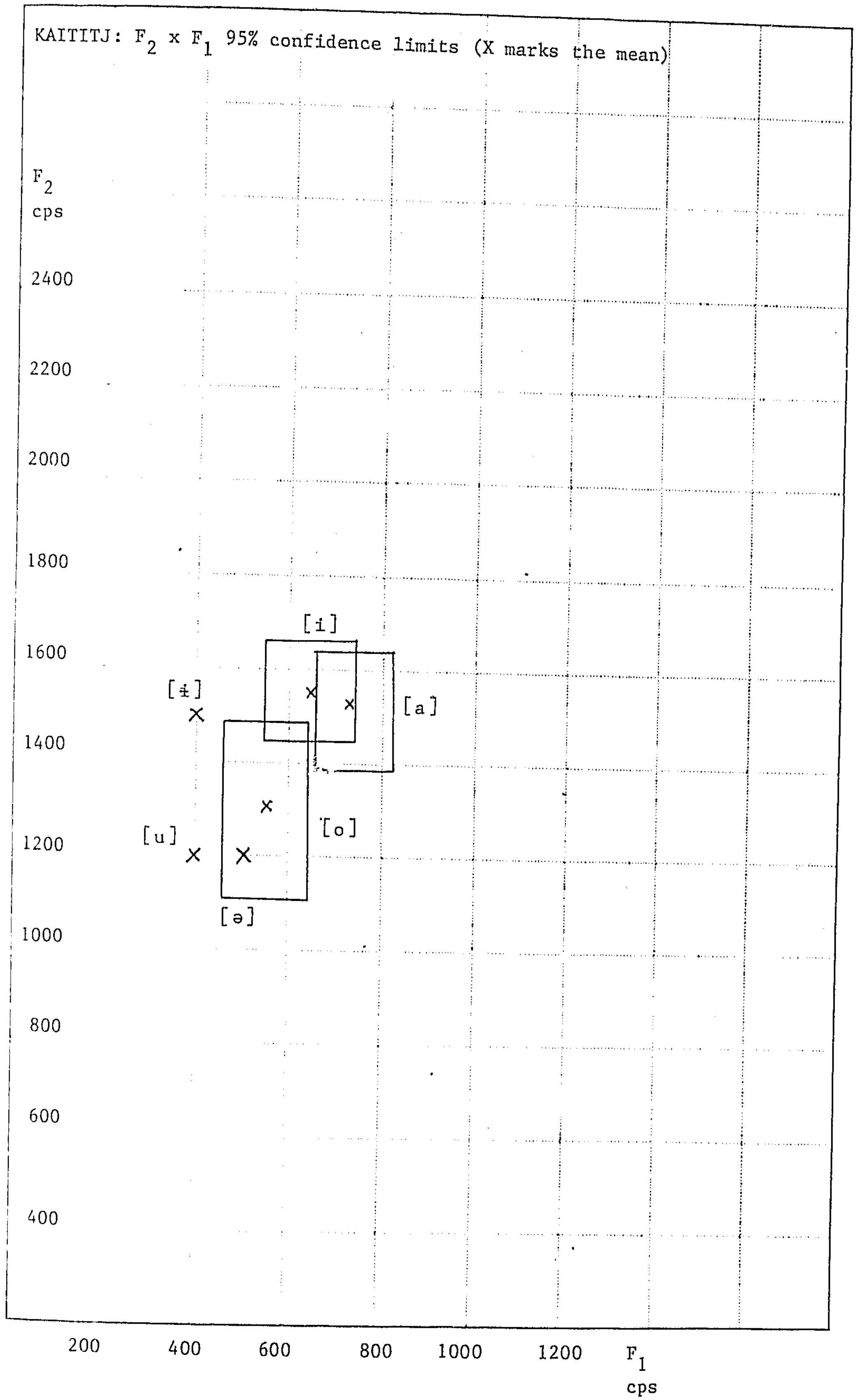
800
1000
1200
F1
cps

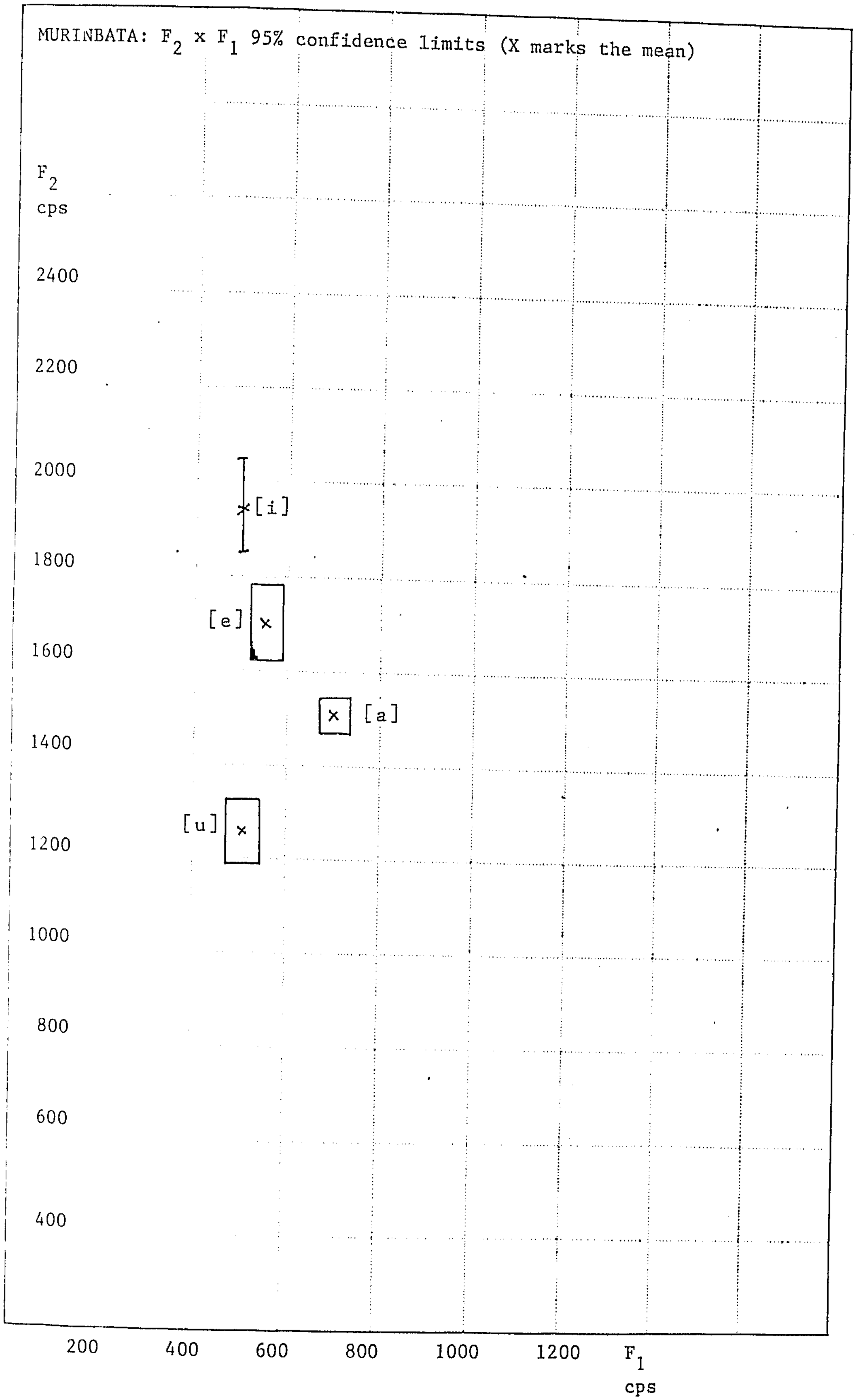

WIKMUNKAN: F_2 x F_1 95% confidence limits (X marks the mean)
F_2
cps
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[e]
[ə]
[e:]
[a]
[a:]
[o]
[o:]
[u]
200
400
600
800
1000
1200
F_1
cps



MPAKWITHI: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[a]
[ɔ]
[u]
200
400
600
800
1000
1200
F1
cps


KURTJAR: F2 x F1 95% confidence limits (X marks the mean)
F2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[e]
[ɨ]
[a:]
[a]
[ö]
[o]
200
400
600
800
1000
1200
F1
cps


KAITITJ: F_2 x F_1 95% confidence limits (X marks the mean)
F_2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[ɨ]
[a]
[o]
[u]
[ə]
200
400
600
800
1000
1200
F_1
cps


MURINBATA: $F_2 \times F_1$ 95% confidence limits (X marks the mean)
F_2
cps
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
[i]
[e]
[a]
[u]
200
400
600
800
1000
1200
F_1
cps

APPENDIX 8:

Spectrographic Examples

(1) Yukulta

(2) Spurious formants

(3) Lateral sections

(4) Nasals sections

(5) Stop Transitions

(6) Glottal Stop

(7) Retroflexes

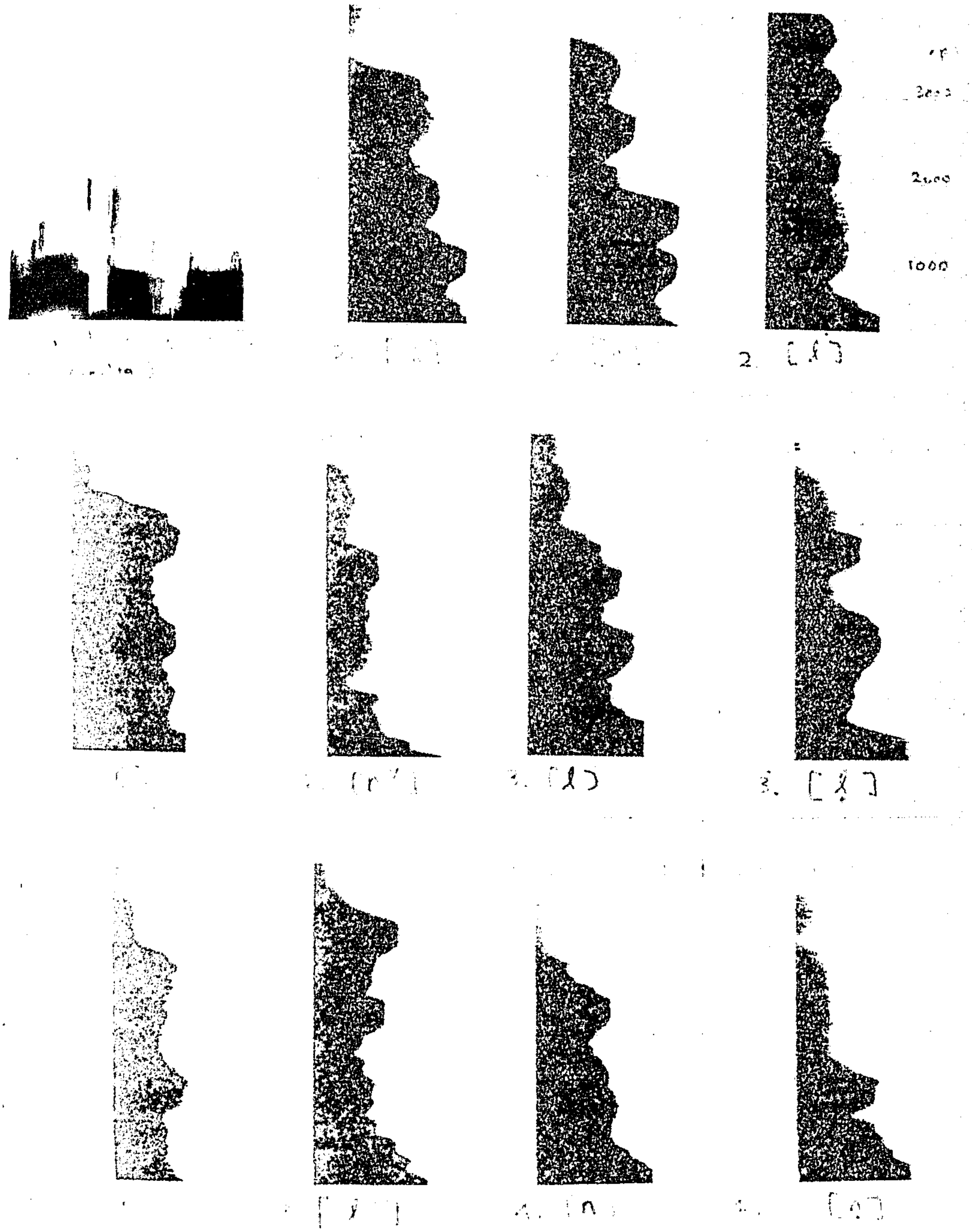
(8) Palato-velars

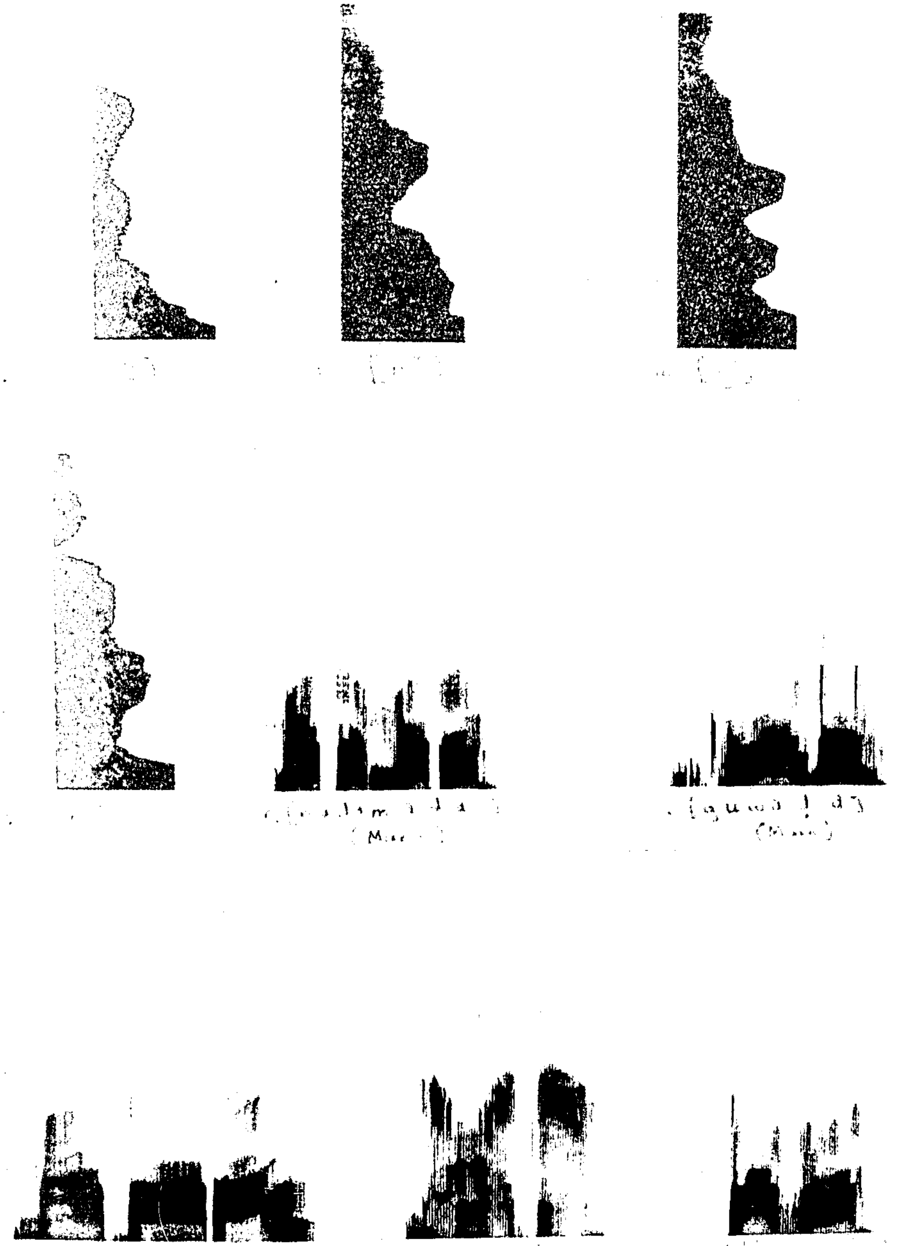
(9) Flaps and Trills

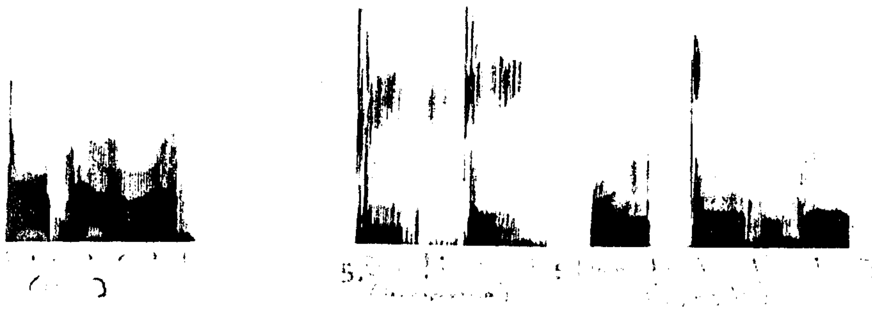
(10) Glided Rhotics

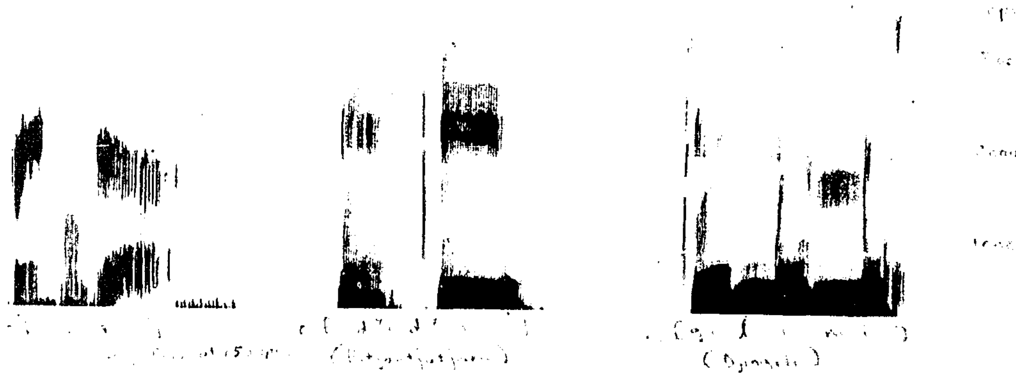
(11) Glides

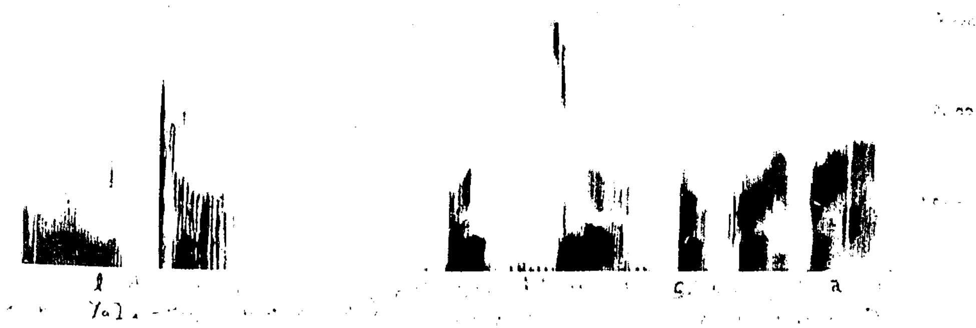
All Spectrographs were made using a high-pass filtered source (high-shaping) on a 0-4000 cps. scale. Language name is in brackets with any Audio-Frequency filter levels also given in brackets.

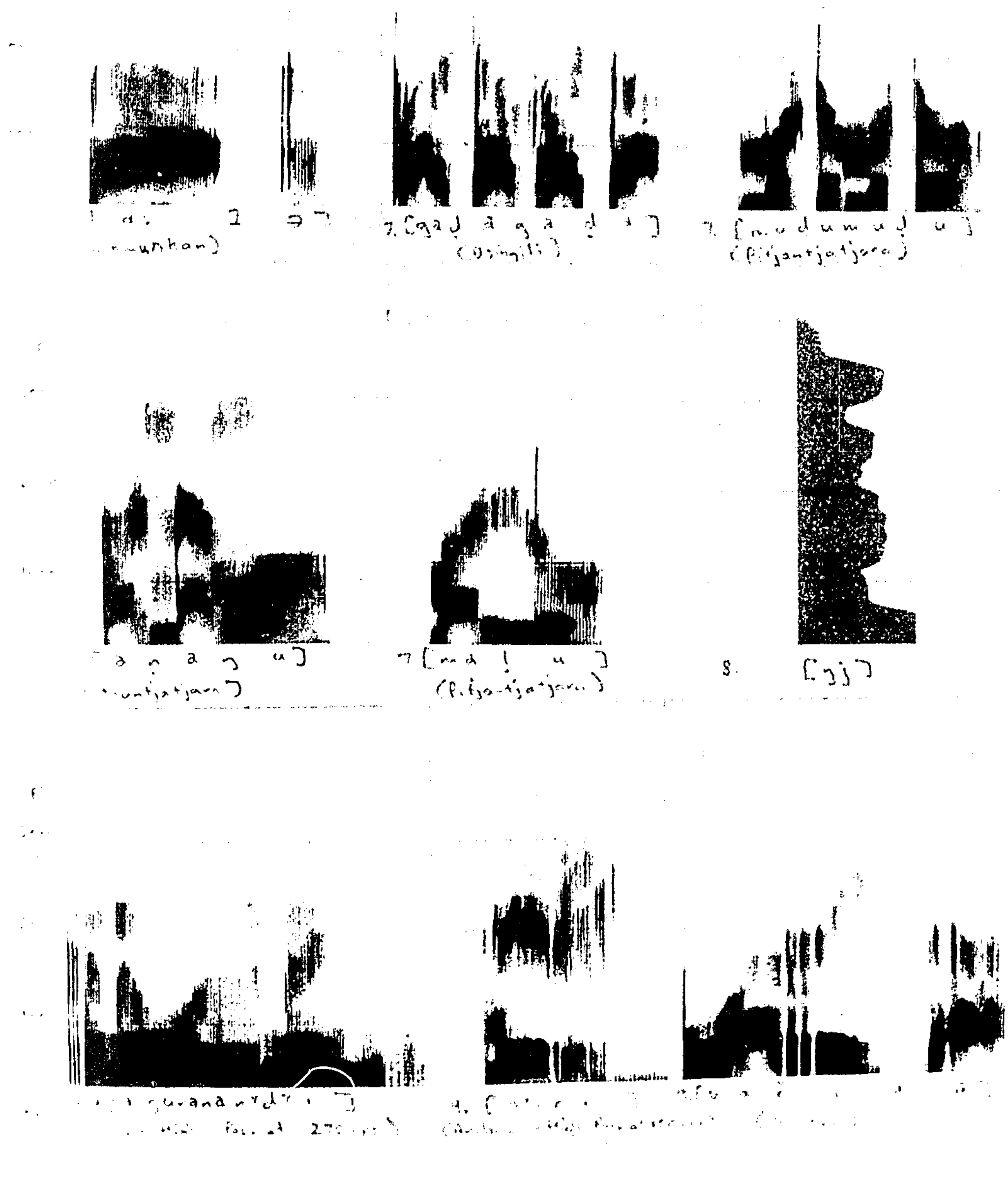

2000
1000

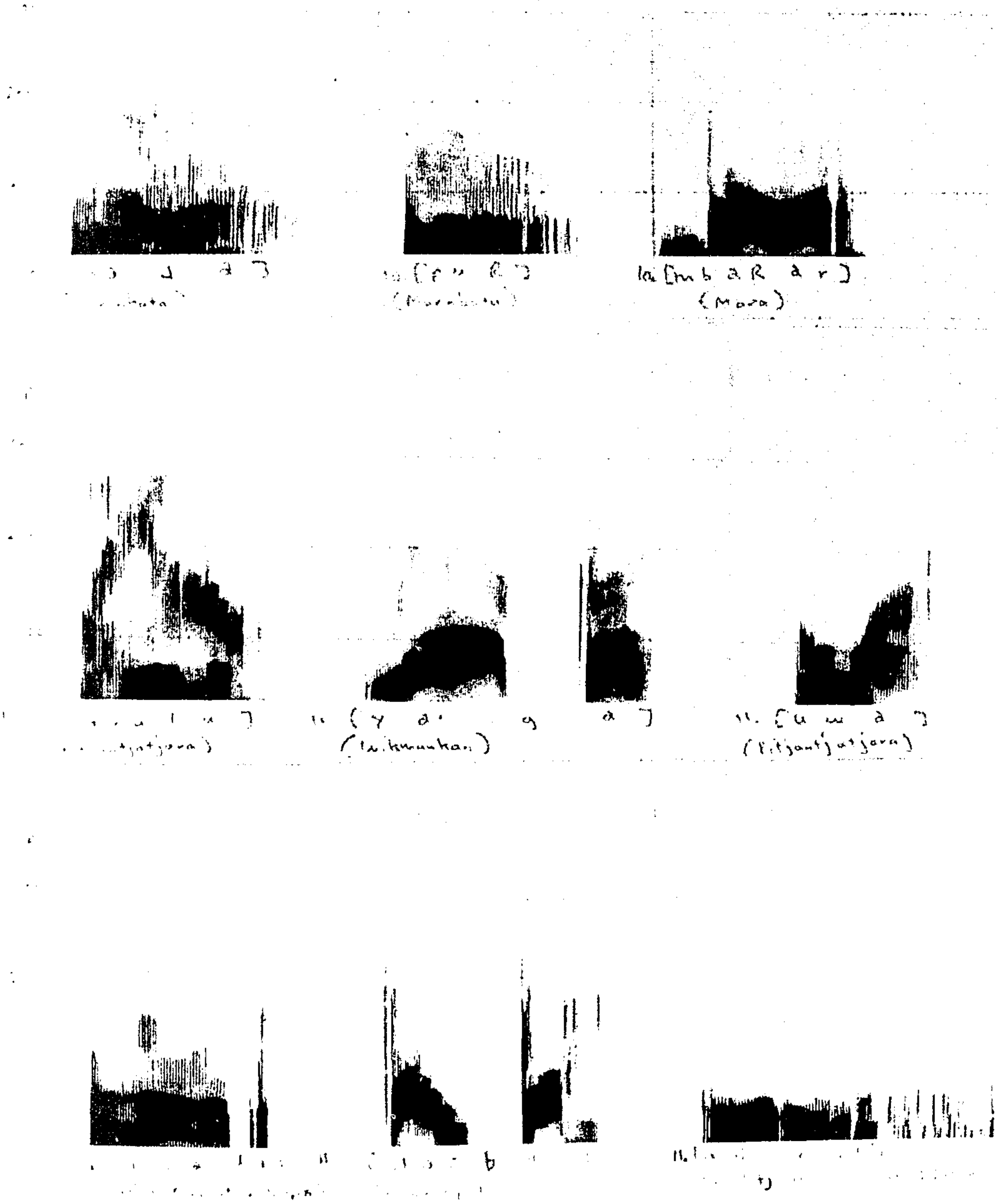











la [m b a R a r]
(Mara)

Language Bibliography

References cited as unpublished can be located in the library of the Australian Institute of Aboriginal Studies (A.I.A.S.).

Order: a, u, b/p, g/k, dy/dj, dh/th, d/t, m, ng, ny/nj, n, l, r, w, y.

The number after each language name indicates the A.I.A.S. area number.

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Bidyara (E37)

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