NASAL SUBSTITUTION RULES IN PONAPEAN

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1. INTRODUCTION[1]

In Ponapean (PNP)[2], a nuclear Micronesian (MC) language[3] spoken in the Eastern Caroline Islands, the two optimal consonant cluster types are those involving (1) geminate sonorants or (2) a sequence of a nasal followed by a homorganic obstruent. An inventory of the consonantal phonemes of PNP is presented in the chart below.[4]

Consonantal Phonemes

	Labial	Dental	Alveolar	Post-Alveolar	Velar
Stops					
Plain	p	t			k
Velarised	p^w				
Fricatives			s^y		
Affricates				ts	
Nasals					
Plain	m	n			ŋ
Velarised	m^w				
Liquids		l	r̃		

For orthographic convenience, these phonemes will subsequently be written as follows.

The Phoneme	Will be Written
p^w	pw
m^w	mw
r̃	r
ts	t'
ŋ	ng

The remaining phonemes will be represented as they are on the preceding chart.

In accord with these orthographic practices, the optimal consonant clusters of PNP may be listed as follows.

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Optimal Consonant Clusters

Geminate Sonorants	Nasal-Obstruent Sequences
mm	mp
mwmw	mwpw
nn	nt
ll	ns
rr	nt'
ngng	ngk

The clusters ns and nt' are homorganic as a result of a process which assimilates n to the position of a following coronal obstruent.[5]

Consonant clusters not of these two types, non-optimal clusters, either do not occur or are subject to modification by (1) the insertion of an epenthetic vowel, (2) the complete assimilation of the first consonant to the second, or (3) the substitution of a nasal for the first of the two consonants in the cluster.[6] The focus of this paper is on the latter phenomenon, which will subsequently be referred to as nasal substitution.

2. SYNCHRONIC NASAL SUBSTITUTION RULES

The first description of nasal substitution in PNP was provided by Paul Garvin (1962:120). He observed:

> Morphemes with final p, t, k have within the same phrase sandhi variants dissimilated to final m, n, ŋ respectively before morphemes with initial consonant identical to their non-contact final....

Among the examples Garvin cited were the following, rewritten here in accord with the transcription system used in this paper.

Morphemes	Pronounced
soop+piir	sompiir
ship+fly	*aeroplane*
mwoot+ti	mwoonti
sit+down	*sit down*
tɔtɔɔk+ki	tɔtɔɔngki
work+instrumental suffix	*work with*

Garvin's account of nasal substitution in PNP, however, is deficient in three respects. First, data not considered by Garvin illustrate that other clusters in addition to geminate p, t, and k may undergo nasal substitution. Second, the condition that these clusters be in the same phrase is not sufficient to explain the constraints on the operation of nasal substitution. Third, nasal substitution is apparently best understood, not as a consequence of dissimilation, but rather of weakening.

The third point above will be explored in Section 4. of this paper, which deals with the motivation for nasal substitution. The first two points will be examined in the remainder of this section, where it will be argued that there are in fact two synchronic rules of nasal substitution, one of which is constrained in its application to reduplicated forms, while the other has a wider domain of application. The nasal substitution rule found in reduplicated forms will be examined first.

2.1. Nasal substitution in reduplication

Reduplication is productively employed in PNP to signal durative aspect.[7] There are at least eleven distinctive surface patterns of reduplication, the occurrence of which is governed by the phonological shape of the word being reduplicated. Two of these patterns, affecting words in which the first three segments are CVC, may lead to consonant clusters, as illustrated by the following examples:

Pattern I: Total Reduplication

rer	*tremble*
rerrer	*trembling*

Pattern II: Partial Reduplication

rere	*peel*
rerrere	*peeling*

Within the framework of generative phonology, both of these patterns may be characterised as initial CVCV reduplication. Evidence for this analysis follows.

As noted in Rehg 1973, there is a synchronic rule in PNP that deletes the final vowel of a polysyllabic base before word boundary; elsewhere, this vowel is retained. Thus, a base of the shape $*C_1V_1C_2V_2$ will surface as $C_1V_1C_2$ (unreduplicated) or as $C_1V_1C_2V_2C_1V_1C_2$ (reduplicated). Examples follow, where the final base vowel (or a conditioned variant of this vowel) is underlined in the reduplicated form.[8]

Word	Gloss	Reduplicated
tep	*kick*	tepetep
tep	*start*	tepitep
kos	*throw*	kosokos
kos	*bent*	kosikos
net	*smell*	netenet
net'	*sell*	net'inet'
let'	*flick*	let'elet'

The base form of an intransitive verb like tep *kick*, therefore, is *tepe (cf. the transitive form tepek). The surface form tepetep is derived as follows:

Base:	tepe
Reduplication:	tepetepe
Final V Deletion:	tepetep

Pattern I reduplication may therefore be characterised as involving total reduplication of *CVCV bases.

Pattern II reduplication, partial reduplication, also involves initial CVCV reduplication, as evidenced by the following examples:

Word	Gloss	Reduplicated
ngalis	*bite*	ngalingalis
sapeng	*answer*	sapesapeng
sakone	*force to do*	sakosakone
marep	*blink*	maremarep

Under certain conditions that I will not discuss here, the vowel of the second reduplicated syllable may be reduced to a high vowel, as the following examples illustrate.

pirap	*steal*	piripirap
lɔnge	*lay across*	lɔngilɔnge

I am not aware of any data which would support the position that these latter forms involve only CVC reduplication, thus enabling one to treat the high vowel that occurs before the base as an epenthetic vowel. On the contrary, evidence not considered in this paper supports the position that these high vowels may be derived from non-reduced vowels and that all of the examples above involve initial CVCV reduplication.[9]

As the preceding examples illustrate, vowels in the environment CVC___&CVCV... (where & represents the boundary type characteristic of reduplication) may be retained. Under conditions to be specified, however, these vowels may also undergo deletion. As a consequence of such deletion, consonant clusters result, some of which are subject to modification by nasal substitution. The conditions under which these vowels are retained or deleted are examined below.

A vowel in the environment CVC_1___$\&C_2VCV...$ will be retained if (1) C_1 and C_2 differ in their values for the feature coronal, or (2) C_1 and C_2 are both non-coronal, but differ in their values for the feature anterior. What happens in the remaining cases is illustrated in the charts below, where the consonants listed down the left side of the chart represent C_1 and the consonants listed across the top represent C_2. A V is used to indicate that a vowel is retained in the environment specified. If the vowel is deleted, the resulting surface cluster is listed. If, because of co-occurrence restrictions on consonant types within a single morpheme, no example exists, an asterisk (*) is employed.[10] If the missing example is presumed to be due to an accidental gap in the language (or in the data), a dash (-) is listed.

Labials

	p	pw	m	mw
p	mp	*	-	*
pw	*	mwpw	*	mwmw
m	-	*	mm	*
mw	*	-	*	-

Velars

	k	ng
k	ngk	-
ng	ngk	ngng

Coronals

	s	t	t'	n	l	r
s	ns	-	-	-	V	V
t	V	nt	*	V	V	-
t'	V	*	nt'	V	V	V
n	ns	nt	nt'	nn	ll	-
l	ns	nt	nt'	-	ll	-
r	ns	nt	nt'	nn	ll	rr

Examples of the clusters listed in the preceding charts are provided in column three below.

Labials

Word	Gloss	Reduplicated	Underlying Cluster
pap	*swim*	pampap	pp
pwupw	*fall*	pwumwpwupw	pwpw
mwopw	*out of breath*	mwomwmwopw	pwmw
mem	*sweet*	memmem	mm

Velars

Word	Gloss	Reduplicated	Underlying Cluster
kak	*able*	kangkak	kk
kang	*eat*	kangkang	ngk
ngong	*bark*	ngongngong	ngng

Coronals

Word	Gloss	Reduplicated	Underlying Cluster
sas	*stagger*	sansas	ss
tit	*build a wall*	tintit	tt
t'at'	*writhe*	t'ant'at	t't'
sinom	*sink in*	sinsinom	ns
tune	*tie together*	tuntune	nt
t'enek	*hung up*	t'ent'enek	nt'
nenek	*commit adultery*	nennenek	nn
linenek	*oversexed*	lillinenek	nl
sel	*tied*	sensel	ls
til	*penetrate*	tintil	lt
t'al	*click, tsk*	t'ant'al	lt'
lal	*make a sound*	lallal	ll
sar	*fade*	sansar	rs
tar	*strike, of a fish*	tantar	rt
t'ir	*narrowing*	t'int'ir	rt'
nur	*contract*	nunnur	rn
lirooro	*protective*	lillirooro	rl
rer	*tremble*	rerrer	rr

Examples of potential clusters where a vowel is retained are:

Word	Gloss	Reduplicated	Flanking Consonants
lus	*jump*	lusulus	s___l
rese	*saw*	resirese	s___r
set	*artificially ripen breadfruit*	seteset	t___s
net	*smell*	netenet	t___n
lituii	*serve as female servant*	litilituii	t___l
setik	*quick in performing*	set'iset'ik	t'___s
net'	*sell*	net'inet'	t'___n
let'	*flick*	let'elet'	t'___l
rot'	*dark*	rot'orot'	t'___r

To account for the the preceding data, it is clear that rules of two types are required. First, one or more vowel deletion rules must be posited to explain the occurring consonant clusters. Second, one or more rules of cluster modification are necessary to deal with the fact that the resulting surface clusters are not necessarily identical to the underlying clusters. In the analysis that follows, it is argued that, in fact, nine synchronic rules are required to account for these data — five rules of vowel deletion and four rules of cluster modification.

In the formulation of these rules, features will be employed only when they permit a more elegant characterisation of a natural class of segments that can be captured through the use of informal notational devices. Also, two ad hoc notational devices will be used in writing these rules. First, following an already common practice, the suprafeature F will be employed to represent all unspecified features. Second, in some rules, two boundary markers will be included within braces to indicate that the rule in question may apply at/across either of these boundaries. The boundary types that play a role in these rules are &, which has previously been identified as the boundary characteristically found between a reduplicated portion of a root and the root itself, and =, which will be used to represent the boundary characteristically occurring between a verb root and directional suffixes.[11] Thus, a rule of the nature

$A \rightarrow B/C\_\_\_\begin{Bmatrix} \& \\ = \end{Bmatrix}D$ specifies that $A \rightarrow B$ in both the environments $C\_\_\_\&D$ and $C\_\_\_=D$.

A full discussion of the role of boundaries in PNP, or even of the role they play in these rules, is well beyond the scope of this paper. Data presented in Section 2.2. will make clear, however, the necessity for at least these two boundary types.

The following nine rules are posited to account for the phenomena summarised in the preceding cluster charts. Reference to those charts while examining these rules should prove useful.

1) Vowel Deletion Rule #1

$$V \rightarrow \emptyset / V \begin{bmatrix} +\text{nasal} \\ \alpha\text{ant} \\ \beta\text{cor} \end{bmatrix} \_\_\_ \begin{Bmatrix} \& \\ = \end{Bmatrix} \begin{bmatrix} +\text{cons} \\ \alpha\text{ant} \\ \beta\text{cor} \end{bmatrix}$$

This rule deletes a vowel in the environment $VC_1\_\_\_\begin{Bmatrix} \& \\ = \end{Bmatrix}C_2$, where C_2 is a consonant homorganic with the nasal C_1.[12] This rule therefore creates the clusters mm, ngk, ngng, ns, nt, nt', and nn, as well as nl, which subsequently becomes ll through the operation of Rule #8.

A V (vowel) must be included as the first segment in the environment of this rule since the first vowel in a word of the shape CV.... may (synchronically) never be deleted or reduced. For example, durative aspect is signalled with morphemes of the shape CVCC or CVVC by reduplicating the initial CV. Note in the following examples of such morphemes that a vowel before & boundary does not delete, even though it is in the correct consonantal environment.

Word	Gloss	Reduplicated
mant	*tame*	mamant
miik	*suck*	mimiik

An identical constraint exists on all of the following vowel deletion rules.

2) Vowel Deletion Rule #2

$$V \rightarrow \emptyset / V \begin{bmatrix} +\text{cons} \\ +\text{son} \\ \alpha\text{F} \end{bmatrix} \_\_\_ \begin{Bmatrix} \& \\ = \end{Bmatrix} \begin{bmatrix} +\text{cons} \\ +\text{son} \\ \alpha\text{F} \end{bmatrix}$$

This rule deletes a vowel in the environment $VC_1 \_\_\_ \{{}^{\&}_{=}\}C_2$, where C_1 and C_2 are identical sonorants. This rule creates ll and rr clusters, and in the absence of Vowel Deletion Rule #1, would also lead to mm, nn, and ngng. (mwmw occurs only as a derived cluster in reduplication.) This rule could therefore be rewritten to delete a vowel only between potential geminate liquids, but, for purposes of simplicity, it seems preferable to state this rule in its most general form.

3) Vowel Deletion Rule #3

$$V \rightarrow \emptyset / V \begin{bmatrix} +\text{cons} \\ -\text{cor} \\ \alpha\text{ant} \end{bmatrix} \_\_\_ \{{}^{\&}_{=}\} \begin{bmatrix} +\text{cons} \\ -\text{cor} \\ \alpha\text{ant} \end{bmatrix}$$

This rule deletes a vowel in the environment $VC_1 \_\_\_ \{{}^{\&}_{=}\}C_2$, where C_1 and C_2 are either both labials or both velars. When considering reduplicated forms, only the cluster mwmw from *pwmw motivates this rule, since Vowel Deletion Rule #1 and Vowel Deletion Rule #4 will account for all other such clusters. Unlike Rule #4, however, this rule also plays a role in non-reduplicated forms. Its importance in such forms will be further examined at the end of this section and in Section 2.2.

4) Vowel Deletion Rule #4

$$V \rightarrow \emptyset / V \begin{bmatrix} -\text{son} \\ \alpha F \end{bmatrix} \_\_\_ \ \& \begin{bmatrix} -\text{son} \\ \alpha F \end{bmatrix}$$

This rule deletes a vowel in the environment $VC_1 \_\_\_ \& C_2$, where C_1 and C_2 are identical obstruents. This rule therefore creates the clusters pp, pwpw, kk, ss, tt, and t't', all of which serve as input to Rule #7, Nasal Substitution.

5) Vowel Deletion Rule #5

$$V \rightarrow \emptyset / V \begin{bmatrix} +\text{son} \\ +\text{cor} \\ -\text{nas} \end{bmatrix} \_\_\_ \ \& \ [+\text{cor}]$$

This rule deletes a vowel in the environment $VC_1 \_\_\_ \& C_2$, where C_1 is a liquid and C_2 is a coronal. This rule creates the clusters ll and rr, as well as the underlying clusters ls, lt, lt', rs, rt, rt', rn, and rl, all of which serve as input to Rule #6.

6) Liquid Assimilation

$$\begin{bmatrix} +\text{son} \\ +\text{cor} \\ -\text{nas} \end{bmatrix} \rightarrow [\alpha F] / \_\_\_ \ \& \begin{bmatrix} +\text{cor} \\ \alpha F \end{bmatrix}$$

This rule states that a liquid will completely assimilate to a following coronal across & boundary. This rule applies vacuously to ll and rr clusters, changes ln, lr, rn, and rl to nn, rr, nn, and ll respectively, and changes all homorganic liquid-obstruent clusters to geminate obstruent clusters which serve as input to Rule #7.[13]

7) Nasal Substitution Rule A

$$\begin{bmatrix} -\text{son} \\ \alpha F \end{bmatrix} \rightarrow \begin{bmatrix} +\text{son} \\ +\text{nas} \\ +\text{voice} \end{bmatrix} \_\_\_ \ \& \begin{bmatrix} -\text{son} \\ \alpha F \end{bmatrix}$$

This rule states that all geminate obstruent clusters that occur with an intervening & boundary will be modified to homorganic nasal-obstruent clusters. Thus, the underlying clusters pp, pwpw, kk, ss, tt, and t't' become mp, mwpw, ngk, ns, nt, and nt' respectively.

8) Nasal Assimilation

$$\begin{bmatrix}+\text{cor}\\+\text{nas}\end{bmatrix} \rightarrow \begin{bmatrix}-\text{nas}\\ \alpha\text{F}\end{bmatrix} \;/\; \underline{\quad\quad}\;\&\; \begin{bmatrix}+\text{cor}\\+\text{son}\\-\text{nas}\\ \alpha\text{F}\end{bmatrix}$$

This rule states that an n before & boundary will completely assimilate to a following liquid. Thus, in reduplicated forms, nl becomes ll. No reduplicated examples exist of nr becoming rr, but other forms in the language evidence that this change does occur.[14]

9) Nasal Substitution Rule B

$$\begin{bmatrix}+\text{cons}\\-\text{cor}\\ \alpha\text{ant}\\ \beta\text{high}\\ \gamma\text{back}\\ \delta\text{round}\end{bmatrix} \rightarrow \begin{bmatrix}+\text{son}\\+\text{nas}\\+\text{voice}\\ \beta\text{high}\\ \gamma\text{back}\\ \delta\text{round}\end{bmatrix} \;/\; \underline{\quad\quad}\,[-\text{Pause}]\; \begin{bmatrix}+\text{cons}\\-\text{cor}\\ \alpha\text{ant}\\ \beta\text{high}\\ \gamma\text{back}\\ \delta\text{round}\end{bmatrix}$$

This rule states that if two labial or two velar consonants come together in the flow of speech (that is, no pause intervenes), the first consonant will become a nasal that copies the features of velarisation (high, back, round) of the second. Within the data previously examined, only the modification of the cluster pwmw to mwmw illustrates the operation of this rule. But this rule is well supported by forms in which reduplication is not involved. The operation of this nasal substitution rule outside of reduplication will be examined in Section 2.2.

The preceding rules will account for all of the surface clusters listed in the charts at the beginning of this section. Admittedly, the fact that nine rules are required to explain these data suggest an inelegant or inaccurate solution. Especially suspicious is the necessity for five rules of vowel deletion. It is by no means obvious, however, how the number of such deletion rules could be reduced. A solution wherein all vowels are deleted before reduplication boundary, and subsequently vowels are inserted to break up impermissable clusters, is ruled out by the fact that the vowels that occur between such potential clusters are not predictable; they are underlying vowels. A solution in which two or more of these deletion rules are collapsed into a single rule also suggests itself, but, in such a solution, one must take into account the fact that the vowel deletion rules previously listed are of two types — those that apply both at & and = boundary, and those that apply only at & boundary. Thus, if the number of vowel deletion rules is to be reduced, one must find a way to combine rules 1 and/or 2 and/or 3 as one set and rules 4 and 5 as another set. The collapsing of rules within these constraints is not possible. It is, of course, possible to restate these vowel deletion rules, and to reorder them, but none of these alternant solutions is better motivated, nor does any come as close as the existing solution to capturing what must have happened historically in the language.[15] Given the current status of research on PNP, nine rules are required.

2.2. Nasal substitution outside of reduplication

Of the two nasal substitution rules cited above, only Rule B applies to clusters outside of reduplication. Rule B states that whenever two labial or two velar consonants come together in speech, therefore no pause intervenes, the following results obtain:

Labials

	p	pw	m	mw
p	mp	mwpw	mm	mwmw
pw	mp	mwpw	mm	mwmw
m	mp	mwpw	mm	mwmw
mw	mp	mwpw	mm	mwmw

Velars

	k	ng
k	ngk	ngng
ng	ngk	ngng

Examples of the application of this rule in polymorphemic words of various types are presented below. The clusters resulting from this rule are underlined in the first column. In the second column, the morphemes of which these words consist are listed as they would occur after the application of all rules except Nasal Substitution Rule B. The dash in these forms simply indicates the presence of a boundary marker which, for the purposes of these examples, may remain unspecified. Eng. glosses are provided in the third column.

Word	Consisting of the Morphemes	Gloss
lompeseng	lop-peseng	*cut apart*
sarempene	sarep-pene	*scrape together*
tɔtɔɔngki	tɔtɔɔk-ki	*work with*
isingki	isik-ki	*burn with*
keemmeirkelik	keep-meir-kelik	*yam variety*
emwpwɔt'ol	ep-pwɔt'ol	*a game*
keemwmwot'	keep-mwot'	*yam variety*
sampaa	sapw-paa	*world, earth*
limwpwɔt'	lim-pwɔt'	*five (oblong things)*
limwmwut'	lim-mwut'	*five (piles)*

Note that the last five examples illustrate regressive assimilation to the features of velarisation.

At normal conversational speed, this rule applies even across word boundary, as illustrated by the following examples:

Sentence: E kalap paan soupisek.
Pronounced: /e kalam paan soupisek/
Gloss: *He'll always be busy.*

Sentence: E kalap men meir.
Pronounced: /e kalam men meir/
Gloss: *He's always sleepy.*

Sentence: E saik kengwini.
Pronounced: /e saing kengwini/
Gloss: *He hasn't yet taken medicine.*

Sentence: E saik nget.
Pronounced: /e saing nget/
Gloss: *He's not yet out of breath.*

Sentence: Soulik kin soupisek.
Pronounced: /souling kin soupisek/
Gloss: *Soulik is (habitually) busy.*

The last example (where Soulik is a noun phrase and kin soupisek is a verb phrase) illustrates that this rule also applies to segments belonging to different syntactic phrases.[16] The constraint on Nasal Substitution Rule B, then, is that it applies to segments within the same phonological phrase; that is, to segments which are not separated by a pause.

Garvin's constraint on nasal substitution, that it applies to segments within the same phrase (assuming that he was referring to phonological phrases) is accurate for homorganic labial and velar clusters. But, coronal consonants do not behave in a parallel manner. Coronal consonants undergo nasal substitution in reduplicated forms only. The nasal substitution rule affecting coronal consonants, Nasal Substitution Rule A, never applies across word boundary, as the following examples illustrate.

Sentence:	E ekis suwet.
Pronounced:	/e ekis suwet/
But Never:	*/e ekin suwet/
Gloss:	*It's kind of bad.*

Sentence:	Ke meit tangaanga!
Pronounced:	/ke meit tangaanga/
But Never:	*/ke mein tangaanga/
Gloss:	*Aren't you lazy!*

Coronal consonants also do not undergo nasal substitution in polymorphemic words, typically because coronal clusters do not arise in such words. Therefore, Vowel Deletion Rules 4 and 5 are constrained so as to apply at & boundary only. In words involving other boundaries, these rules do not apply and coronal clusters do not result, as illustrated by the following examples.

Word	Consisting of the Morphemes	Gloss
isisel	isi+sel	*seven (ropes)*
isisop	isi+sop	*seven (stalks)*
palisal-	pali+sal-	*side exposed to*
weitita	weiti=ta	*proceed upward*
pɔteti	pɔte=ti	*plant downward*
lusisang	lusi=sang	*jump from*

In these examples, the final vowel of the base is retained before + and = boundary. However, even where an enclitic boundary occurs, before which base final vowels delete, nasal substitution does not apply. Either a copy vowel is inserted to break up the coronal cluster or the cluster occurs without further modification. Note the following examples:

mwemeit'et'e	mwemweit'#t'e	*just visiting*
massuwet	mas#suwet	*ugly*

The example Garvin cited of mwoonti *sit down* from mwoot *sit* and -ti *down* would appear to violate the claim that coronal consonants do not participate in nasal substitution except in reduplication, but in fact this form is anomalous. This same verb followed by the directional suffix -ta *upward*, for example, results in the form mwootata. One explanation for the occurrence of the form mwoonti rather than mwootiti (which some speakers also accept) is that this verb so often occurs with this particular suffix that the boundary normally present between verbs and directional suffixes (= boundary) was replaced by the tighter boundary & and the correct environment for Nasal Substitution Rule A arose. It is also possible that this form simply underwent lexicalisation early in the history of PNP and that diachronically Nasal Substitution Rule A operated morpheme-internally as well as across & and possibly other boundaries. Some support for this latter position is offered in the section that follows.

3. DIACHRONIC APPLICATIONS OF NASAL SUBSTITUTION RULE A

Synchronically in PNP, homorganic nasal obstruent clusters occur not only in polymorphemic words, but morpheme-internally as well. Morpheme-internal examples of such clusters follow.

	Initially	Medially	Finally
mp	(i)mpe *next to (it)*	tempel *kava pounding rhythm*	emp *coconut crab*
mwpw	(u)mwpwul *flame*	semwpwe *turn windward*	(u)mwpwɔmwpw *low hill*
nt	(i)ntil *torch fish*	manta *next day*	mant *tame*
ns	(i)nsar *snare*	kounsup *frowning*	kens *yaws*
nt'	(i)nt'a *blood*	eent'a *fish sp.*	kent' *urine*
ngk	(i)ngket *thatch*	lingkiri *oyster*	engk *landslide*

The vowel enclosed in parentheses before initial occurrences of such clusters is a predictable vowel. Further comments on the origins of this vowel will be presented later in this section.

Considerable evidence exists to support the position that at least some of these clusters arose from earlier geminate obstruent sequences that underwent Nasal Substitution Rule A, or some historical antecedent of this rule. Considering PNP data alone, this position is weakly supported by the nature of the distribution of geminate consonants morpheme-internally.

Occurring	Non-Occurring
mm	*pp
mwmw	*pwpw
nn	*tt
ll	*ss
rr	*t't'
ngng	*kk

Note that whereas all sonorants occur geminate morpheme-internally, obstruents never do.[17] The skewed distribution of these segments could obviously be explained by assuming that all geminate obstruent clusters were modified by nasal substitution.

The most perusasive evidence in support of this position, however, comes from external comparisons with other MC languages. Compare, for example, the previously cited PNP forms containing initial nasal-obstruent clusters with their cognates in Trukic (TK). (Lagoon Trukese (TRK) forms are employed except where noted.)

PNP	TK
(i)mpe *next to (it)*	ppa- *next to --*
(u)mwpwul *flame*	pwpwun *flame*
(i)ntil *torch fish*	ttúl- (Saipan Carolinian) *fish with a light*
(i)nsar *snare*	ssar *snare*
(i)nt'a *blood*	čča *blood*
(i)ngket *thatch*	kket *thatch*

In these examples, the nasal-obstruent clusters of PNP systematically correspond to the geminate obstruent clusters of TK.

Since geminate consonants do not occur initially or in any other position in Proto-Oceanic (POC) reconstructions, the presence of such clusters constitutes a problem in understanding the history of these languages. Goodenough (1963) recognised this problem and argued that morpheme-internal geminates in TRK developed as a consequence of vowel deletion in earlier morphologically complex forms. TRK morphs with initial geminates, he stated "reflect older forms with classic first syllable reduplication" (Goodenough 1963:78), as evidenced by cognates in Kiribati (KIR) (Gilbertese).

KIR	TRK
raraa *blood*	čča *blood*
kakang *sharp*	kken *sharp*

Such reduplication is not evidenced in POC (*daRa(?) *blood*),[18] but it does apparently date back as far as Proto-Micronesian (PMC *t'at'aa *blood* and *kakangi *sharp*).[19] What function this pattern of reduplication served is not entirely clear.

It is also not entirely clear how a PNP form such as (i)nt'a *blood* developed from PMC *t'at'aa, but one possible scenario follows.

PMC	*t'at'aa
1) Metathesis	at't'aa
2) Nasal Substitution	ant'aa
3) Vowel Reduction	int'aa
4) Final Vowel Deletion	int'a
5) Reduced Vowel Deletion (Optional)	(i)nt'a

Comments concerning the motivation for constructing this particular scenario follow.

That a rule of metathesis might have existed diachronically in PNP is supported by evidence from Marshallese (MRS). The developments affecting potential initial geminates in the Ratak and Rālik dialects of this language are particularly suggestive of what might have happened in PNP.[20]

Ratak	Rālik	Gloss
kẹkẹn	yẹkkẹn	*invent*
liliw	yilliw	*angry*

The Ratak forms are the result of earlier CV- reduplication, where the vowel between the potential geminates is not deleted. In the Rālik dialect, however, as possibly in PNP, metathesis has taken place (along with the development of a prothetic y) and geminates result.

The diachronic rule governing nasal substitution was apparently identical to Nasal Substitution Rule A, presented in the last section, with one important difference. Whereas the synchronic rule of nasal substitution must be constrained so as to operate only across & boundary, the diachronic rule apparently also operated morpheme-internally. Considering only forms involving earlier initial CV- reduplication, this position is tenuous, but can be argued. Therefore, since a form such as *t'at'aa *blood* was already inherently reduplicated in PMC, it does not seem unlikely that this form at some point relatively early in the history of these languages underwent lexicalisation, so that no internal boundary remained. At least, it does not seem unlikely that this boundary information was lost by the time nasal substitution applied, which was apparently no earlier than Proto-Ponapeic (PPP). Nasal substitution is not found outside this subgroup. Since the time depth between PMC and PPP is unknown, however, this argument is weak. Further justification for this position is necessary and will be provided in the discussion of the origin of medial and final nasal-obstruent clusters.

To account for the synchronic shape of a word such as (i)nt'a *blood*, a diachronic rule of vowel reduction is also required. The effect of this rule was to reduce metathesised vowels to either u or i, depending upon the rounding of the following segment.[21] Therefore, these vowels were reduced to u before (1) clusters of velarised labial consonants, and (2) clusters of other consonants followed by a round vowel, thus leading to the rounding of the preceding segments. Elsewhere, these vowels reduced to i. This is the synchronic situation, as illustrated by the following examples.

Initial u

umwpwer	*twin*
ungkopw	*crab sp.*

Initial i

impe	*next to (it)*
inta	*say*
int'a	*blood*
ingkapwan	*a while ago*

The last two developments, Final Vowel Deletion and the optional rule of Reduced Vowel Deletion, are well attested synchronic rules of PNP.

One might, of course, construct alternate scenarios that would equally well account for synchronic surface forms like (i)nt'a. I am not certain, for example, whether Nasal Substitution was a later or earlier development than Vowel Reduction. I am confident, however, that the optional, predictable vowels that occur in such forms represent vowels that, from a historical perspective, are in the process of being lost, rather than added. In earlier analyses of PNP, I had in fact taken the opposite position.[22] Because these vowels are optional and predictable, I assumed that they originated as prothetic vowels. While such an analysis might be possible in a synchronic grammar of

PNP, it is now clear that forms such as (i)nt'a must have developed from an earlier int'a. As evidence for this position, consider the fact that among all the speech communities that make up Ponapeic (PP), it is only in PNP that these vowels are optional. In Ngatikese (NGK), for example, the initial vowels before nasal-obstruent clusters may never be deleted, as illustrated by the following examples.[23]

PNP	NGK	
(i)mpaai	impaai	*submissive*
(u)mwpwɔs	imwpwos	*boil*

Note, further, that in NGK the vowel that precedes these clusters is always i, regardless of the rounding of the following segment. In light of this observation, the following forms are particularly interesting.

PNP	NGK	
(u)mwpwel	imwpwel	*crab sp.*
(u)mwpwel	umwpwel	*earth oven filled with food*

While the first NGK example has an initial i, the second does not. It is not the NGK form which is aberrant, however. It is the PNP form. In both PNP and NGK, the word umwpwel is, historically at least, a compound consisting of the two morphemes umw *earth oven* and pwel *earth*.[24] In PNP, therefore, the first vowel of the word umwpwel is being treated precisely like the metathesised reduced vowels of earlier reduplicated forms and is consequently subject to deletion.

Further support for the position that these vowels are being lost is provided by a comparison of the following forms in PNP and Mokilese (MOK) (Harrison 1977).

PNP	MOK	
mmat'	immas	*ripe*
mwmwus	umwmwuj	*vomit*

The geminate sonorants that occur in these forms in both languages also apparently arose as a consequence of initial CV- reduplication, metathesis, and vowel reduction.[25] In MOK, the resulting initial high vowels are retained in these forms, but in PNP they are completely lost. Thus, the rule optionally deleting initial vowels before homorganic nasal-obstruent clusters in PNP appears to be an extension of a rule which historically deleted such vowels before geminate sonorants. There thus appears to be little doubt that the optional initial vowels that we have been examining represent vowels in the process of being lost rather than added. The importance of this in explaining the motivation for nasal substitution will be examined in the next section of this paper.

So far as I am aware, except for the aberrant form (u)mwpwel, all surface initial occurrences of nasal-obstruent clusters derive historically from underlying geminate obstruents, where the first obstruent underwent nasal substitution. The origin of morpheme-internal nasal-obstruent clusters in other positions, however, is not so well understood, primarily due to the difficulty of finding non-PP cognates with these forms. Apparently, though, these clusters arose in two distinct ways.

First, non-initial nasal-obstruent clusters arose morpheme-internally as a result of the deletion of a vowel that was preceded by a nasal and followed by a consonant homorganic with that nasal. Vowel loss in this environment occurred in earlier morphologically complex forms, as illustrated by the following example.

menseng	From:	mani+sangi
morning		*animal+cry*

Vowels were also lost in this environment in monomorphemic words, however, as illustrated by the next example.

mant	From: POC	*manasa
tame		*tame*

The rule that governed this vowel deletion was the progenitor of synchronic Vowel Deletion Rule #1, cited in the preceding section. For reasons that I will not explore in this paper, the synchronic version of this rule must be constrained so that it will operate only at & and = boundaries, but, as the form mant illustrates, this rule did operate morpheme-internally diachronocially.

Second, non-initial nasal-obstruent clusters arose morpheme-internally as a consequence of nasal substitution. Such clusters occur in forms involving a now-fossilised pattern of -CVCV final reduplication, as the following example illustrates.[26]

opampap	From:	*opapa&papa
humble		

Vowel Deletion Rule #4 and Nasal Substitution Rule A, as synchronically stated, will account for the preceding form, but some evidence exists that both of these rules also operated morpheme-internally. Consider, for example, the word for 'coconut crab' in the following languages.

PNP:	emp
MOK:	opup
Woleaian (WOL):	yaff

Further research will be required to determine precisely how the synchronic vowel deletion and cluster modification rules operated diachronically. It seems likely, however, that all of these rules played a role in the origin of morpheme-internal clusters in modern PNP.

4. THE MOTIVATION FOR NASAL SUBSTITUTION

The presence, either diachronically or synchronically, of nasal substitution rules is one of the defining characteristics of PP languages. No other nuclear MC language exhibits this phenomenon, nor, so far as I am aware, does any other OC language. Nasal substitution is by no means a common phonological development. Thus, why such rules should have developed in PP is a question of both historical and theoretical interest.

Fischer (1965:1496) takes up this question and argues that nasal substitution in PNP is stylistically motivated. He notes that, across word boundary, TRK and PNP treat homorganic consonant clusters in antithetical ways. "In Trukese, the preference is for clusters of two identical stops (articulated as a single long stop), while in Ponapean the preference is for clusters of nasal plus stop." The Sandhi rules presumably leading to these clusters, he notes, are as follows (where **N** = nasal, S = stop, and subscript **a** = point of articulation).

	Underlying Forms	Result of Sandhi
Trukese	$...N_a\ S_a...$	$...S_a\ S_a...$
	$...S_a\ S_a...$	$...S_a\ S_a...$
Ponapean	$...N_a\ S_a...$	$...N_a\ S_a...$
	$...S_a\ S_a...$	$...N_a\ S_a...$

Based on the cultural attitudes toward speech as they are influenced by the social structure of these speech communities, and on the occasions on which he heard the sandhi rules apply or fail to apply in PNP, Fischer (1965:1500) hypothesises that

> there is a common expressive significance for each of the two types of consonant clusters in the two languages. Specifically, in both languages the double stops seem to have the value of abruptness and freedom of emotional expression, while the clusters of nasal plus stop seem to have the value of restraint, politeness, and gentleness.

Ponapeans, who value restraint and the avoidance of overt expressions of aggression in speech, prefer nasal-stop clusters because of their symbolic value. Trukese, who are more aggressive in their speech behaviour, prefer double stops. He further suggests that the patterns displayed by TRK and PNP might be explained in terms of a "potentially universal symbolism" (p.1500). Double stops involve a more forceful vocal gesture, and may thus be expressive of aggression, while nasal-stop clusters are less forceful, and may thus be expressive of restraint.

I do not disagree that phonetic symbolism plays a role in language, but I think Fischer's position, that such symbolism motivated nasal substitution, fails in two ways. First, Fischer's account of the rules which govern nasal substitution follows Garvin's analysis, and is thus wrong. As noted in the second section of this paper, coronal stop clusters do regularly occur across word boundary and, within certain prosodic configurations, in other environments as well. It is not simply the case, therefore, that geminate stops are avoided in PNP; their occurrence is governed by a complex series of phonological rules. Second, I suspect that while phonetic symbolism may play a role in determining the shape of some morphemes, it does not normally, if ever, dictate regular sound change.[27] Labov has noted, of course, that social and stylistic factors play a role in sound change, but these factors serve to influence the utilisation or non-utilisation of otherwise phonetically or functionally motivated processes. The motivation for nasal substitution can, I believe, be explained in these terms.

One obvious motivation for nasal substitution is the functional role it plays in limiting the number of optimal consonant cluster types in PNP. As demonstrated in the second section of this paper, nasal substitution rules interact with a complex series of other rules as part of a conspiracy to reduce 144 potential consonant cluster types to 12 optimal ones. Thus, nasal substitution is motivated in part by the role it plays within the phonological system of PNP.

Nasal substitution would also appear to be well-motivated on perceptual grounds. Voiceless geminate obstruents are difficult to perceive, especially when they are in initial or final position.[28] By lowering the velum and adding voicing to the first obstruent — the changes involved in nasal substitution — this perceptual problem is alleviated. Many languages, of course, do tolerate voiceless geminate obstruents, and some languages (MOK for example) even have rules which create such clusters.[29] On the whole, though, rules which simplify such clusters appear to be far more common, probably for the reasons cited above.

The lowering of the velum involved in nasal substitution also suggests a physiological motivation for this phenomenon. Sheldon Harrison first noted that the conversion of an obstruent to a nasal in this environment

> can be viewed as a response to the heightened pressure inherent in geminate obstruents. This pressure can be reduced by lowering the velum to allow some air to escape through the nasal cavity, thereby destroying the obstruent articulation.[30]

Another motivation for nasal substitution rests on the claim I wish to advance, that this phenomenon is not the result of dissimilation, as Garvin proposes, but rather is a consequence of weakening. As Johnson (1973:52) has insightfully noted, "What appears...as a dissimilatory state...may not be due to a dissimilatory process." Johnson, along with Foley (1972), takes the position that many seemingly dissimilatory processes involving contiguous segments may be better explained in terms of weakening. It is therefore of significance that in PNP, both synchronically and diachronically, nasal substitution affects consonants in syllable-final position. The two rules of nasal substitution operate in the following environments (where $ represents syllable boundary):

Initial	Medial	Final
#VC$CV...	...VC$CV...	...VC$CV#

Hooper (1976:196) and others have argued that certain environments are particularly conducive to weakening. One such environment for consonants is syllable-final position, the environment described above.

The terms 'weakening' and 'strengthening' are commonly employed in discussions of sound change, but as Sommerstein (1977:228) has noted, "their definitions have tended to remain intuitive rather than explicit..." Weakening processes for consonants, however, are typically those which result in less obstruction and/or increased sonority, with the extreme case of weakening being deletion. Based upon the extreme case of deletion, an explicit definition of weakening has been attempted by Hyman (1975:165) who states "a segment X is said to be weaker than a segment Y if Y goes through an X stage on its way to zero". Hyman's definition very nicely supports the position that nasal substitution in PNP is, in fact, weakening, as evidenced by data from Pingelapese (PNG), a PP language bordering on mutual intelligibility with PNP. In PNG, the word for *blood*, for example, is iisa (cf. PNP (i)nt'a).[31] Considerable evidence exists to support the position that this form developed from an earlier issa that underwent nasal substitution, resulting in insa. Subsequently, the n was deleted and the preceding vowel was lengthened to maintain the original number of moras in the word. Thus, following Hyman's definition, it can be argued that nasals are weaker than obstruents, since, as PNG evidences, obstruents go through a nasal stage on their way to zero.

The motivation for the weakening of consonants in syllable-final position, and thus a motivation for nasal substitution, is almost certainly related to the fact that the single universal syllable type is the open syllable - CV. Within OC, and PNP, this is the dominant syllable type. Substituting a nasal for a syllable-final obstruent would appear to be one way of opening up the syllable, as evidenced by the many languages in the world that permit only open syllables or syllables ending in a nasal. Thus, nasal substitution may represent an attempt to restore the optimal pattern of syllables in PNP, sequences of open syllables, that was violated by earlier vowel deletion rules.

It is not possible, nor is it even desirable, to single out one of the motivations I have suggested as being the 'correct' or the 'major' motivation for nasal substitution. Quite likely, all of these considerations played a role in the development of this phenomenon. The problem posed by Fischer - why a related language like TRK did not develop nasal substitution, but in fact developed rules creating geminate obstruents - of course remains. It is not the task of this paper to answer that question, but it seems likely that in TRK sufficient numbers of surface geminate obstruents occurred that a change was effected in the preferred syllable type. Further research into this question is required.

NOTES

1. I wish to thank Byron W. Bender, Iovanna Condax, John L. Fischer, Ward Goodenough, Jimmy Harris, Irwin Howard, Jeff Marck, and David Stampe for discussing with me some of the ideas expressed in an earlier draft of this paper. The responsibility for the final form of this work is mine alone.

2. Ponapean (PNP) is spoken by approximately 16,000 residents of the island of Ponape in the Eastern Caroline Islands.

3. Included in nuclear Micronesian are Kiribati (KIR) (formerly Gilbertese), Marshallese (MRS), Kosraean (formerly Kusaiean) (KSR), the Trukic (TK) languages, the Ponapeic (PP) languages, and possibly Nauruan. The PP subgroup includes PNP, Ngatikese (NGK), Mokilese (MOK), and Pingelapese (PNG).

4. The consonant represented as ts in this chart is labelled post-alveolar. The precise position of articulation of this consonant, however, is in doubt. So far as I have been able to determine, it is produced by placing the blade of the tongue against or slightly behind the alveolar ridge, while the sides of the tongue are in contact with the upper gums approximately as far back as the palatal region. Further comments on the segmental phonemes of PNP are presented in Rehg 1973.

5. I have not yet determined precisely how this process should be formalised. It operates, however, in at least the following environments (where C represents a coronal consonant and $ represents a syllable boundary): nC, nVC, and nVCV.

6. The insertion of epenthetic vowels is briefly commented on in Section 2.2. It should also be noted that while geminate obstruents never occur morpheme-internally in native vocabulary, they do occur in some loan words from Jp. (e.g. nappa *Chinese cabbage*). They also arise across morpheme boundaries in particular prosodic configurations.

7. PNP also evidences several fossilised patterns of reduplication, including final -CVCV reduplication. This latter pattern is briefly commented on in Section 3.

8. Only high and mid vowels surface in the environment CVC___&CVC, where V is a non-low vowel, due to a rule which raises low vowels in this and similar environments.

9. In certain segmental and/or prosodic environments, full vowels are reduced to high vowels. High vowels in PNP function as 'minimal' vowels and, in these same environments, are subject to deletion in rapid speech.

10. These co-occurrence restrictions are discussed in Rehg 1973, Section 2.3.

11. A third boundary not dealt with in this paper is the boundary characteristically found between nouns and possessive suffixes.

12. For the purposes of this rule, t' is treated as +anterior. However, if t' is in fact articulated far enough behind the alveolar ridge that it must be considered -anterior, then this rule will not work. In this case, one could either formulate two rules in place of Vowel Deletion Rule #1 — one which would operate on coronals and one which would operate on non-coronals — or one could allow the process described in note 5 to operate before this rule.

13. In MOK, a PP language in which nasal substitution is no longer productive, homorganic liquid-obstruent clusters surface as geminate obstruents. In MOK, as in PNP, this rule operates only in reduplicated forms. See Harrison (1976:45).

14. This rule operates optionally in other environments as well. Therefore, nanleng *heaven* (from nan *in* and laang *sky*) may also be pronounced nalleng. Similarly, nan Ruk *in Truk* may in rapid speech be pronounced nar Ruk.

15. Actually, the overlapping involved in these rules, at least historically, is not surprising. For example, because Rule 1 accounts for nasal-obstruent clusters as well as nasal-sonorant clusters, and in fact deletes vowels between all geminate sonorants except ll and rr, a new rule, Rule 2, arises which takes care of these exceptions. Synchronically, these rules have not progressed to the point where vowels simply delete before & boundary, but one can speculate this is the direction in which the language is heading. In fact, MOK apparently has moved rather far along toward just such a treatment of these vowels.

16. Patterns of intonation in PNP, however, are determined by syntactic constituents. Thus, suprasegmental and segmental phenomena are governed by phrases of different types.

17. Except, as noted in note 6, in some Jp. loan words.

18. POC reconstructions are from Grace (1969).

19. PMC reconstructions are from Marck (1977).

20. From Abo et al. (1976) and Karen Kaeo (personal communication).

21. The notion of 'reduction' is appropriate here since non-high vowels are changed to high vowels, the minimal vowels in PNP. See note 9.

22. I stated this position in a number of unpublished papers, and it is implicit in Rehg (1973).

23. NGK is mutually intelligible with PNP. It is spoken on the atoll of Ngatik, located approximately 90 miles south-west of Ponape.

24. This form is also interesting from the point of view of reconstructing the material culture of Ponape. While the contemporary Ponapean oven is built on the surface of the ground, and is never covered with earth, this form suggests an earlier technique of building such ovens underground, as is the more common practice in the Pacific.

25. Vowel reduction applies vacuously in the case of *umwmwus.

26. See Harrison (1973) for a discussion of final reduplication in MC languages.

27. For example, surface-initial (u)mwpw clusters in PNP do seem to have a phonoaesthetic function. Morphemes beginning with this sequence of sounds typically involve the semantic notion of 'roundness', as illustrated by the forms (u)mwpwe *curve*, (u)mwpwei *ball*, (u)mwpwek *bud of a flower*, (u)mwpwel *blister*, (u)mwpwet *to blister*, (u)mwpwi *a drop*, (u)mwpwokos *humpback*, (u)mwpwos *boil*, (u)mwpwɔmwpw *low hill*, (u)mwpwun *barnacle*, and so on. Final əmp clusters in English seem to have a similar value, as evidenced by *hump*, *lump*, *rump*, *clump*, *dump*, etc.

28. But it is possible to perceive even geminate stops in these positions. The articulation may be more fortis, and slight differences in the colouring of the adjacent vowel may occur. Also, there may be visual clues, such as the shape of the speaker's mouth.

29. See note 13.

30. Harrison (1983:359). This motivation for nasal substitution was also suggested to me independently by Ward Goodenough and Jimmy Harris.

31. Elaine Good, personal communication.

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