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A Laryngoscopic Study of Glottal and Epiglottal/Pharyngeal Stop and Continuant Articulations in Amis—— an Austronesian Language of Taiwan

Jerold A. Edmondson[1], John H. Esling[2],
Jimmy G. Harris[2], and Tung-chiou Huang[3]
University of Texas at Arlington[1]
University of Victoria[2]
Dong Hwa University[3]

This paper argues that there are phonetic articulations describable as glottal constriction, epiglottal constriction, and epiglottal articulation with lingual pharyngealization, and that these sound types are found in the Amis language of Taiwan. We shall also show that the glottal, epiglottal, and pharyngeal locations for stop and fricative articulation form a natural class in the phonological system of Amis. To the best of our knowledge, no other language—not even within Austronesian—has such a rich and complex set of lower throat contrasts. In Amis the primary evidence comes from direct examination of the laryngeal-pharyngeal plane of a native speaker producing examples of Hsiukuluan Amis while being observed visually and recorded on digital video. Such activity would be impossible to describe without the laryngoscope, because the lower throat is difficult to access, cloaked in darkness, and rapidly moving.

Key words: Amis language, epiglottal, pharyngeal, laryngoscope

1. Introduction

There are several themes running through this paper. The first is that sounds can be produced by glottal articulation, by epiglottal articulation (laryngeal constriction), and by epiglottal articulation with lingual pharyngealization (laryngeal constriction with substantial pharyngeal tongue retraction). From this emerges the second claim that glottal and epiglottal/pharyngeal locations of stricture represent a natural class of sounds that can enter into phonological rules. And finally, we conclude that sounds with epiglottal and pharyngeal points of stricture are significantly represented in the Austronesian language family, just as they are in Semitic, Caucasian, and in the Salish and Wakashan languages of the northwest coast of North America. As for the first theme, Esling argues in his 1999 paper that there was no good evidence for “two

distinct places of articulation in the pharynx", i.e. epiglottal vs. pharyngeal. In Arabic, for example, some have described the "voiced resonant" sound of the lower throat as a fricative, others as an approximant, and still others as a stop (with description of the location of stop stricture being left ambiguous). Esling argues that instead of *place*, distinctions in pharyngeal sounds are a function of *manner* of articulation or a function of *larynx height*, basing his argument on phonetic grounds. John McCarthy in an undated paper makes similar arguments on phonological grounds. Traditionally, even the reconstructed proto-phoneme set includes only the glottals /ʔ h/ and the "pharyngeals" /ʕ ħ/. The "pharyngeals" of Arabic and Oriental Hebrew are described by Laufer & Condax (1981) as phonetically epiglottal, with epiglottis as active articulator. McCarthy (nd:4) also says,

> The main gesture in the production of the pharyngeals is an approximation of the posterior wall of the laryngopharynx and the tongue root from the epiglottis down to the larynx. Both the posterior pharyngeal wall and the tongue root are moved inward from their rest positions. Concomitantly, the larynx itself and adjoining structures are raised considerably. The constriction is significantly narrower for ħ than for ʕ.

McCarthy further speculates:

> The voiceless pharyngeal ħ is some kind of fricative or approximant (or perhaps even a glide). The realizations of ʕ vary dialectally or even individually between a stop (presumably epiglottal) and an approximant or fricative. Al-Ani (1970) found that he and three Iraqi informants produced ʕ as a stop (cf. El-Halees 1985). …But, according to Catford (1983:347), there is a Caucasian language ("the Burkikhan dialect of the Dagestanian language Agul") which does have distinct stop and continuant ʕ phonemes. Another possibility of phonemic contrast is that between plain and glottalized ʕ, found in Columbian Salish (Kinkade 1967). Further properties of ʕ and ħ involve the larynx. I have already noted that the larynx is considerably raised during the production of the pharyngeals (Ghazeli 1977), and ʕ is often accompanied by creaky voice. This phenomenon is probably not unique to Arabic; Hayward and Hayward (1989), citing Sasse (1979) and Hayward (1989), note that ʕ is frequently "glottalized" in Ethiopian (Semitic and Cushitic) languages.

Keeping phonological and phonetic descriptions distinct, we shall call ʕ a **voiced resonant** and ħ a **pharyngeal fricative**, and we recognize that different dialects of Arabic have different phonetic realizations of the voiced resonant. Our examinations of Arabic suggest that the voiced resonant may occur as a voiced approximant or as an epiglottal-pharyngeal stop. Esling has shown in his studies (1996, 1999) that in all of the so-called pharyngeal and epiglottal articulations, the epiglottis is the passive articulator and the aryepiglottic folds are the active articulator. Cf. the evidence of Zeroual (1999, 2000) and of Zeroual & Crevier-Buchman (2002) compared with the video images below.

Figure 1: Arabic /ʔi/ ‘yes (Palestinian)’ vs. /ʕi/ ‘understand’

In the *Handbook of the IPA*, Thelwall & Sa’adeddin (p.53) describe /ʕ/ as a “Retracted Tongue Root glottal stop” and say, “Nowhere have we observed a pharyngeal fricative.” We agree that “fricative” is not a good description and instead would suppose that it is an approximant, possibly with a bit of friction due to slight trilling of the aryepiglottic folds. Our Palestinian pictures showed little of the aryepiglottic folds, but auditorily it did make the impression of being trilled. Zeroual has shown that the Moroccan varieties of these sounds are a pure approximant (with the trilled enhancement in prosodically emphatic situations) and the point of articulation is aryepiglotto-epiglottal (2002). Single slides as in Figure 1 cannot show the manner of articulation, which can only be determined auditorily.

The idea of common pharyngeal-epiglottal linguistic terrain is also reflected in the IPA phonetic symbols. Also in the IPA handbook (p.163), the recently revised symbol tables indicate a significant increase to five in the number of recognized sounds in the lower throat. Now the IPA has no.144, a **voiceless pharyngeal fricative** [ħ], no.145, a **voiced pharyngeal fricative** or **approximant** [ʕ], no.172, a **voiceless epiglottal fricative** [ʜ], no.173, an **epiglottal plosive** [ʡ], and no.174, a **voiced epiglottal fricative** [ʢ].

This paper will be looking at the case of Amis, an endangered language of Taiwan that has one fricative /h/ and two stops /ʔ ʡ/ in the lower throat or “laryngeal” region.

The glottal stop /ʔ/ is not an underlying lexically determined segment, but added by a rule to "cover" syllables that begin or end with a vowel. In contrast to /ʔ/, which is introduced by rule, is a lexically specified second laryngeal stop, which we identify as epiglottal/pharyngeal. It may occur initially or medially but when it appears word-finally it requires fortition or strengthening. Indeed, generally, stops and continuants receive greater force of articulation when they appear in word-final position after all morphological units—of which there can be many—are assembled. Thus, there is a glottal stop introduced to cover and separate syllables, as in *ina* [ʔinɑʔ] 'mother', *mama* [mɑmɑʔ] 'father' and *saan* [sɑʔɑn] 'to say' and a second stop with epiglottal/pharyngeal stricture that is lexically specified, as *'oner* [ʡonər] 'snake, serpent' and *'epah* [ʡə̰ɑħ] 'alcohol'.[1] The glottal stricture in a word such a *ina* resembles what we have called in earlier work a **moderate glottal stop**, which has vocal fold adduction, followed by ventricular incursive (VI) partial covering of the vocal folds by the ventricular folds; cf. Esling & Harris (2003). The second phonologically contrastive sound has a different point of constriction that begins with a moderate glottal stop as just described, but then the aryepiglottic folds and arytenoid cartilages constrict upward onto the laminar under-surface of the epiglottis to form an **epiglottal stop**. And finally, in lexical items with word-final /ʡ/ a different point of constriction can be observed. After the formation of an epiglottal stop (which itself presupposes a moderate glottal stop), the epiglottal surface is drawn back over the laryngeal vestibule as a consequence of strong lingual retraction inherent in sphincteringso that the tongue and epiglottis are pressed against the pharyngeal wall. Phonologically, only /ʔ/ and /ʡ/ contrast, and they are implemented phonetically as [ʔ] in *amis* [ʔɑmisː] 'Amis', *kaen* [kɑʔən] 'to eat' or *roma* [romɑʔ] 'other', and are distinct from /ʡ/, which is implemented as [ʡ] initially and medially, and as [ʡ͡ʔʰ] finally, e.g. in *'icep* [ʡtsəpʰ] 'betel nut', *po'ot* [poʡo̯tʰ] 'small knife', and *loma'* [ɾumɑ̯ʡ͡ʔʰ] 'house'.

It is also possible for three progressive points of stricture to occur in fricatives that correspond to the stop sounds. The data to support the brief descriptions just presented will be based on direct observation using the Kay Elemetrics Rhino-Laryngeal-Stroboscope RLS 9100 System with Olympus ENF-P3 flexible fiberoptic bundle. Images were captured on digital video for later viewing and editing. Before turning to that, however, we present a brief introduction to the Amis language.

[1] The writing system for representing Amis in this paper is a slightly modified version of the system used for the Bible translation and Fey's dictionary 1985 and is very close to the underlying phonological representation of words. The apostrophe signifies an epiglottal stop and nothing is written for epenthesized glottal stops, c is /ts/, d is /ɬ/, and e is /ə/. There is still debate about whether distinctive graphs /o/ and /u/ need to be written.

2. Amis

Amis is an Austronesian language spoken on the east side of Taiwan from Hualien in the north to Taitung in the south. It extends along the coast from Peipu village in Hualien County to Malan village in Taitung County and is also found in one inland rift valley paralleling the coast. The population is said to number 140,000, but less than 50% of these can speak the language today and most of those are over 50 years of age. They form over 38% of the aboriginal peoples living in Taiwan and Orchid Island. Tung-chiou Huang is a speaker of the Hsukuluan variety of Amis about 50 km south of Hualien from a village called 舞鶴 Wǔhè.

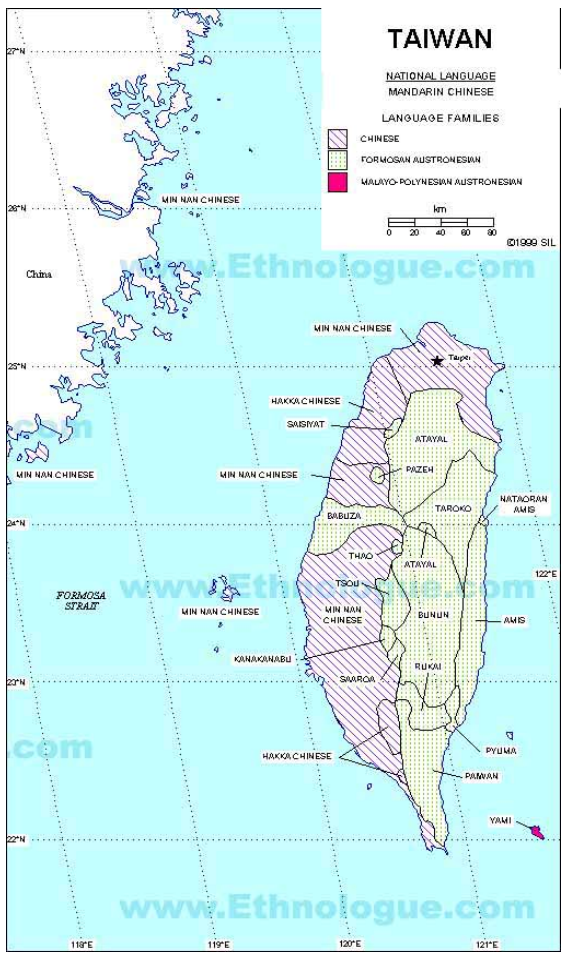
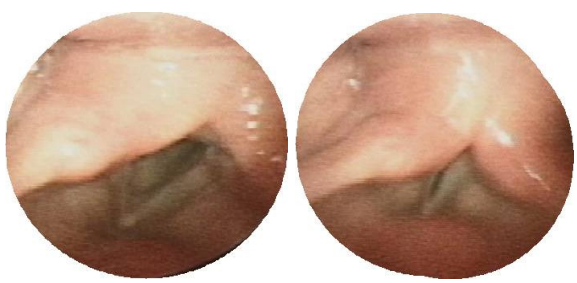


Figure 2: Map of the Amis area

3. The glottal stop, epiglottal stop, and epiglotto-pharyngeal stop

The first of the stops, the moderate glottal stop, is describable in terms of the glottic and ventricular planes alone. The gesture train in this sound involves adduction of the vocal folds as its first element and the partial covering and damping of the vocal folds by the ventricular folds (**ventricular incursion** or VI). In Figure 3 below we present slides taken from the videos for Amis *ina* 'mother' [ʔinɑʔ]. Frame 1 begins in the breath position. In Frame 5 adduction of the vocal folds has taken place, which is then quickly followed by VI in Frame 7 and by the glottal closure with ventricular damping and reinforcement in Frame 9. In Frame 13 the ventricular folds uncover, and voicing of the vocal folds begins. But in all these stills one can see the open or later the hawk-eye-shaped aperture onto the glottal plane afforded by a somewhat closed epiglottal plane that never achieves complete sphincteric closure. In the accompanying spectrogram the frames have been located in time by inspection of the gesture train in the Wavesurfer acoustical analysis software to show the relationship between the articulatory events and the sound production events. Sometimes there can be small errors of timing, as the capture of events takes place at only 30 frames/second, and afterward they had to be matched visually against a corresponding slide from the video.



Frame 1 Frame 5

Frame 7 Frame 9

Frame 13

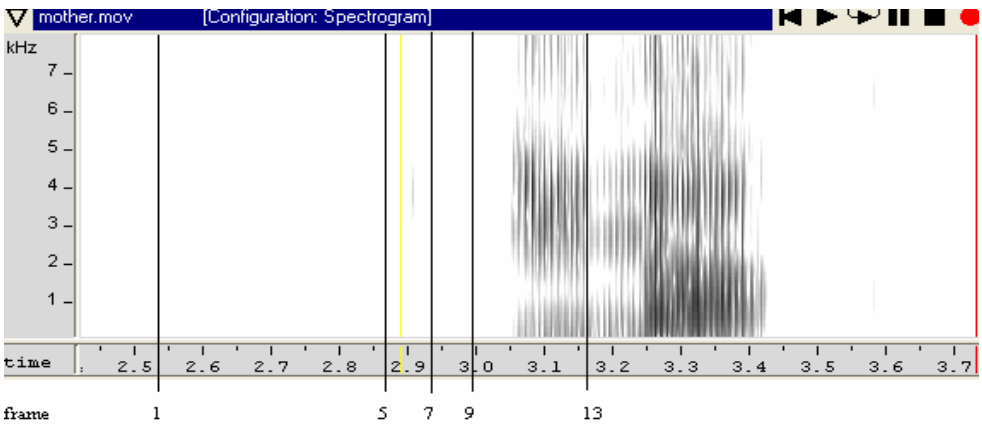
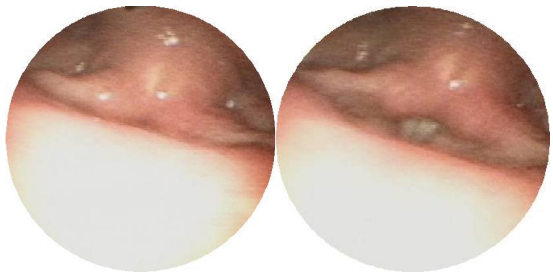


Figure 3: Moderate glottal stop with ventricular incursion in Amis *ina* [ʔinɑʔ] 'mother'

An epiglottal stop occurs at the onset of *'ikong* [ʢikoŋ] 'to bend' and begins with the adduction of the vocal folds and ventricular incursion as before, but then goes on to the sphinctering of the aryepiglottic area. In Frame 1 the abducted vocal folds signify the breath or start position. Frame 3 shows the adduction of the vocal folds with the ventricular folds closing atop the vocal folds to damp their motion. In Frame 5 the arytenoids rapidly move posterior-to-anterior as the larynx rises and press up onto the epiglottal undersurface to effect complete stoppage. Finally, there is release of this voiceless aryepiglotto-epiglottal stop into voice in Frame 8.

Frame 1 Frame 3



Frame 5 Frame 8

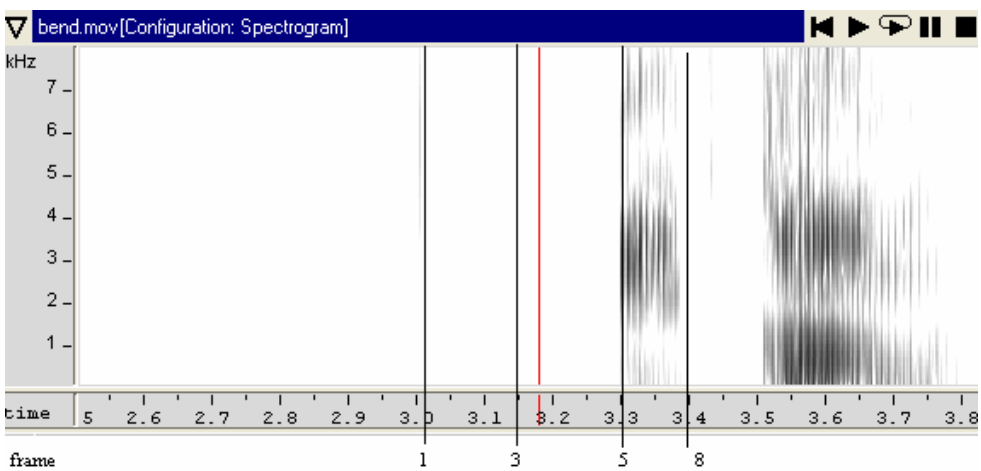
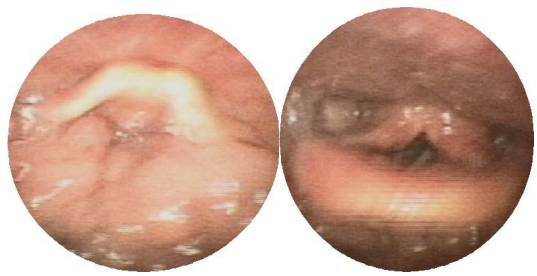


Figure 4: Aryepiglotto-epiglottal stop in Amis *'ikong* [ʔikoŋ] 'to bend'

The slide sequences in Figures 3 and 4 are in sharp contrast to those from the videos of *riri'* 'grasshopper' [riri͡ʡʰ]. Frame 1 begins in course of the second vowel articulation with adducted and phonating vocal folds. Frame 4 shows VI as well as posterior-anterior compacting of the arytenoids onto the tubercle of the epiglottis with sphinctering to a point that only a tiny sliver of the vocal folds remains visible (a glottal stop). Then in Frame 5 there is elevation of the larynx, pressing of the arytenoid cartilages onto the epiglottal undersurface (an epiglottal stop) and very rapid tongue root retraction taking the attached epiglottis in a posterior and elevated direction in Frame 5. The backing movement of the root of the tongue continues toward the back wall of the pharynx completely obscuring the aryepiglottic area and arytenoid cartilages. Upon reaching its terminus, the laminar surface of the epiglottis is pressed strongly against the back of the pharyngeal wall with only the tip of the epiglottis visible over the tongue root (Frame 6). After release (Frame 13), the epiglottis returns to a neutral position and the open glottal folds become visible beneath the arytenoids. This sequence of gestures represents the most extreme degree to which the airway-protecting laryngeal

constrictor sphinctering mechanism can go to achieve complete and efficient closure.

Frame 1 Frame 4 Frame 5



Frame 6 Frame 13

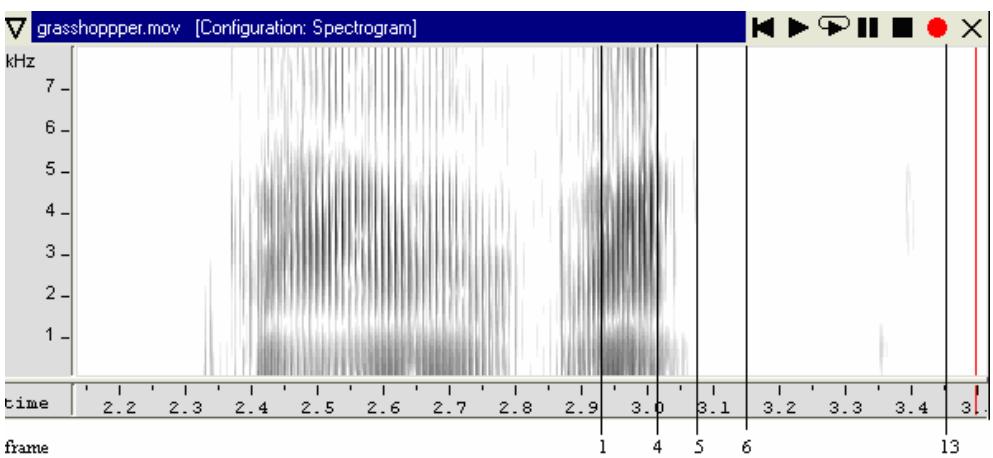


Figure 5: The epiglotto-pharyngeal stop in Amis *riri'* [riri͡ʡʰ] 'grasshopper'

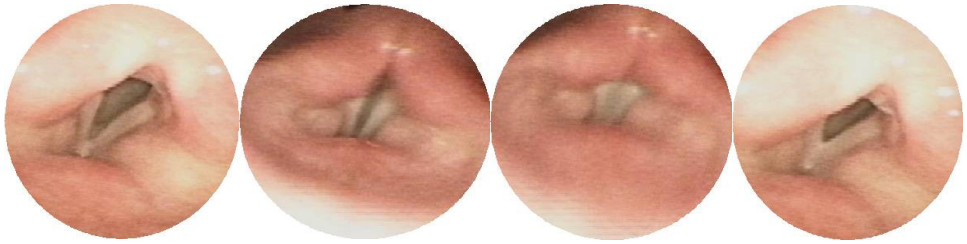
Thus, Figures 3, 4 and 5 show the three degrees of stop stricture of Amis. The moderate glottal stop with VI (Figure 3) has been observed in our work on English, Thai, Pame, Yi, and Bai. The aryepiglotto-epiglottal stop (Figure 4) in contrast to a moderate glottal stop is more common than previously believed, and we have seen it in

Somali, Nuuchahnulth, Nlaka'pamux, Thai (in emphatic contexts), Tigrinya, and Arabic. Relatively uncommon is the voiceless aryepiglotto-epiglottal epiglotto-pharyngeal stop (Figure 5), which is an articulatorily strengthened variant of the epiglottal stop. In the literature this voiceless epiglotto-pharyngeal stop has been called a *linguo-pharyngeal articulation* and a *radico-pharyngeal articulation*, neither of which is descriptively adequate (Catford 1977). The Amis voiceless aryepiglotto-epiglottal epiglotto-pharyngeal stop is articulated with the retracted root of the tongue carrying the epiglottis with it and moving backwards at the same time that aryepiglotto-epiglottal closure is also achieved. Thus, the epiglottis and the tongue function here as a lingual articulator with the back wall of the pharynx as the place of articulation, but this only occurs in conjunction with the initial closure of the aryepiglottic mechanism beneath. Since, as far as we know, complete epiglotto-pharyngeal stop stricture is unreported in the phonetic literature, this finding needs to be described in some detail.

The direction of movement of the active articulator in an epiglottal stop and in an epiglotto-pharyngeal stop is different. In the epiglottal stop the active articulators are the aryepiglottic folds, which move anteriorly and make contact with the epiglottis. In the epiglotto-pharyngeal stop the aryepiglottic folds move anteriorally and make contact with the epiglottis, but the epiglottis and tongue move rapidly in a posterior direction and make contact with the back wall of the pharynx. The epiglotto-pharyngeal stop [ʡ͡ʡ] contains within it a glottal stop and an epiglottal stop. In an epiglottal stop [ʡ͡ʡ] the closure between the aryepiglottic folds and the epiglottis is the primary stricture. The complete adduction of the vocal folds is a secondary stricture and the adduction of the ventricular folds is a tertiary stricture. When there is epiglotto-pharyngeal stricture of an epiglottal stop the primary stricture is the closure between the epiglottis and the back wall of the pharynx. The closure between the aryepiglottic folds and the epiglottis is a secondary stricture and the glottal and ventricular strictures are tertiary strictures, all of which are a part of this complicated stop.

4. The voiceless glottal, epiglottal, and epiglotto-pharyngeal fricatives in Amis

Not only does Amis exhibit three degrees of articulatory stricture in stops, but it also has three degrees of stricture in fricatives. Consider first *hinam* [hinam] 'find out'.



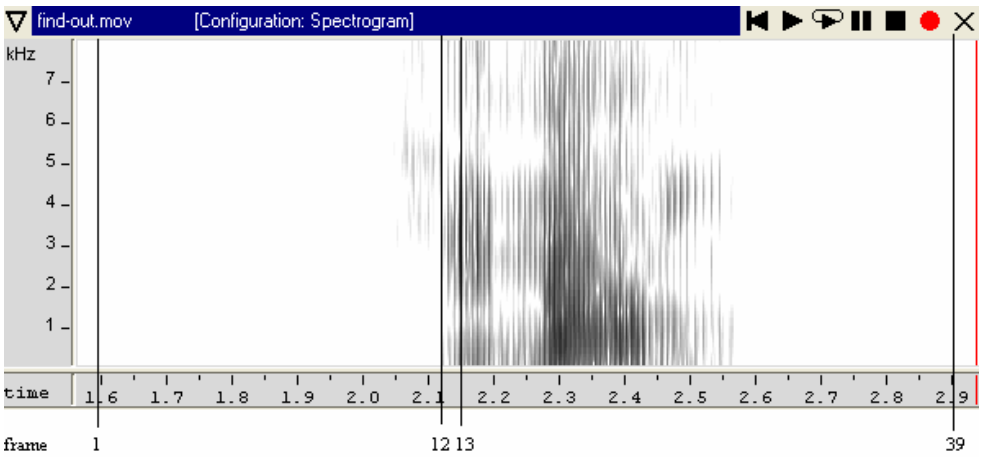
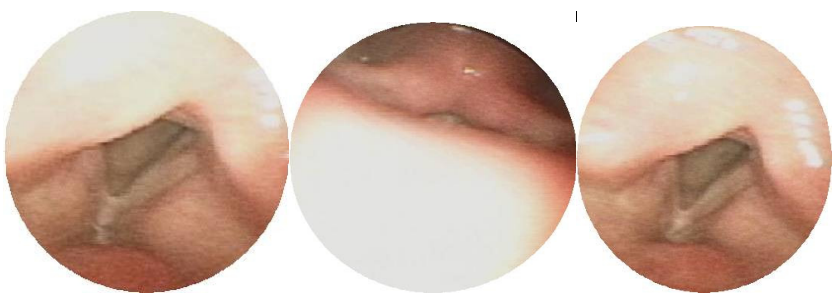


Figure 6: The stages in the production of the glottal fricative [h] in *hinam* [hinam] 'find out'

The Frames 1 and 39 show the glottis in the breath state at the beginning and end of the gesture-train. Frame 12 was taken just before the vowel burst, which is seen in Frame 13. As in the case of the glottal stop only the glottal-ventricular level is involved.

There is also, corresponding to the epiglottal stop, an epiglottal fricative seen in *tihi* [tiʜi?] 'accompany'. It is marked by substantial larynx raising.



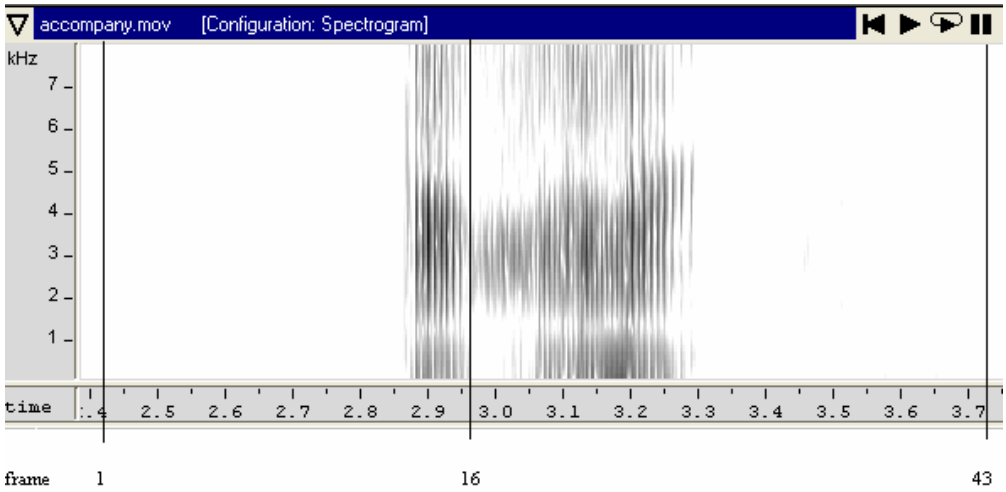


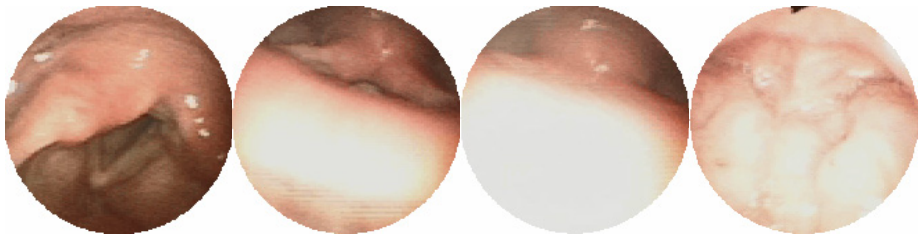
Figure 7: The stages in the production of the epiglottal fricative [ʜ] in [tiʜi?] 'accompany'

In Frames 1 and 43 we see the breath position before and after the syllable. Frame 16 shows the epiglottal fricative between the two [i]'s. Notice the close approximation and the slight opening between the arytenoid cartilages and the epiglottal surface as they move forward in a sphinctering maneuver but without complete closure of either the glottis or of the laryngeal constrictor mechanism.

The epiglotto-pharyngeal fricative [ʜ͡ħ] occurs word-finally in lexical items such as *felih* [fəliʜ͡ħ] 'to turn over'.[2] Frame 1 begins in the breath position. Frame 12 shows the epiglottis retracted almost covering the glottal aperture. Frame 16 shows the tongue and epiglottis retracting and lowering over the glottal aperture as the aryepiglottic constrictor mechanism narrows in a forward and upward direction. But in Frame 22 the tongue root has been drawn even further in the posterior direction and the epiglottis is covered completely, though the spectrogram shows and our auditory assessment confirms that air continues to be expelled.[3]

[2] There is no one symbol for the epiglotto-pharyngeal fricative in the Handbook of the IPA. We have combined, therefore, the epiglottal fricative and the pharyngeal fricative symbols to depict this complex sound until a symbol can be assigned to it.

[3] We have ignored the effects of strong lingual-epiglottal retraction on neighboring vowel and voice quality, which is considerable.



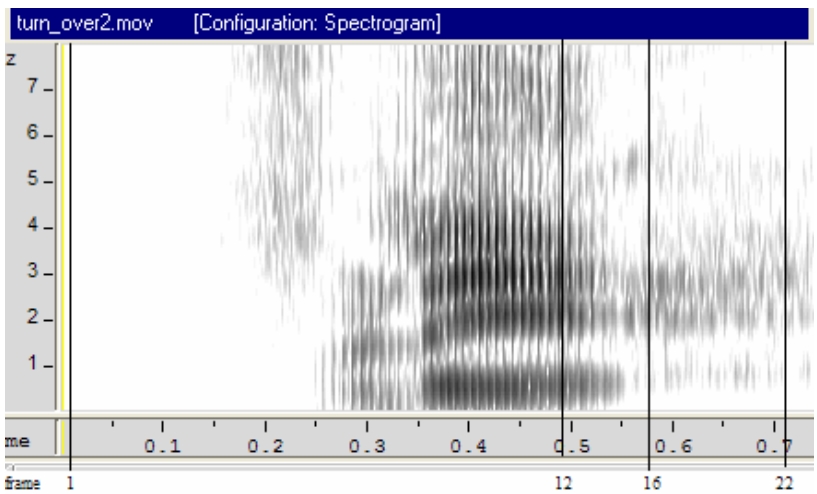


Figure 8: Stages in the production of the pharyngeal fricative in *felih* [fəliḥ] 'to turn over'

The phonetics of the fricatives thus mirrors the stops in having three different degrees of epiglottal and pharyngeal stricture. Now, we noted above that not all of these various manifestations of stop and fricative articulations in the lower throat are phonologically distinctive in Amis. In fact, our analysis of the language shows that there is only one phonological contrast for the fricative manifestations and two for the stop manifestations.

In conclusion, Amis may be the first case of a language with articulatorily stable allophones using the glottal, aryepiglotto-epiglottal, and epiglotto-pharyngeal stricture points. In each case our impression is that the articulation is of progressively greater duration, with more contact area, and with greater movement of articulators. Amis is a language that has final stress on nearly all of its lexical items (save for those with reduplication); it is perhaps the heavy stress at the ends of words that has led to greater enhancement of the closure through added constriction. At the same time word beginnings have been weakened, as is seen in the whispered (voiceless) vowels in the first or second syllables of word roots.

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Jerold A. Edmondson
Department of Linguistics and TESOL
University of Texas at Arlington
Arlington, TX 76019-0559
USA
j.edmondson@sbcglobal.net

Tung-chiou Huang
Department of Language and Communication
of Indigenous Peoples
Dong Hwa University
Shou-feng, Hualien 974, Taiwan
akiyo@mail.ndhu.edu.tw

阿美族語言中的聲門喉音、會厭軟骨與咽喉音：台灣南島語族語言之一

Jerold A. Edmondson[1], John H. Esling[2], Jimmy G. Harris[2], 黃東秋[3]
德州大學阿靈頓分校[1]
加拿大維多利亞大學[2]
國立東華大學[3]

本文探究的是喉塞音發音的議題。當喉塞音在發音過程中，發音方式可以區隔成：(a) 聲門收縮的喉塞音 (glottal constriction)，(b) 會厭軟骨喉塞音 (epiglottal constriction)，(c) 喉塞音的咽頭化 (epiglottal articulation with lingual pharyngealization) 三類，而台灣的阿美族語言中這三類發音方式都有。我們也在阿美族語言的語音體系中，把這三類發音方式歸類成合乎常理的一種語音體系。就以我們的專業素養認爲南島語族諸語言中或沒有其他語言像阿美族語一樣，具有如此豐富而複雜的低喉塞音對比現象。此結論基於秀姑巒阿美族語發音人的例詞發聲，通過鼻腔進行的喉頭鏡觀察和同時進行數位的錄影，使我們能清楚看到咽腔和喉腔的細節變化。假如沒有現代化的聲學語音學喉鏡設備，探究這種發音方式是無法進行的，因爲低喉在喉腔深處，很難探及，而且發音時快速移動使我們絕對無法仔細觀察與分析。

關鍵詞：阿美族語，會厭軟骨，咽頭，喉頭鏡