A laryngoscopic study of glottal and epiglottal/pharyngeal stop and continuant articulations in Amis—an Austronesian language of Taiwan

Jerold A. Edmondson
University of Texas Arlington
Department of Linguistics and TESOL
Arlington, TX 76019-0559
USA

John H. Esling and Jimmy G. Harris
Department of Linguistics
University of Victoria
Victoria BC V8W 3P4
Canada

Huang Tung-chiou
Department of Indigenous Languages and Communication
Dong Hwa University
Hualien, Taiwan, Republic of China

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). A second claim emerges from the first, that glottal and epiglottal/pharyngeal locations of stricture represent a natural class of sounds that can enter into phonological rules. Finally, 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. On the first theme, Esling argued in his paper "The IPA categories "pharyngeal" and "epiglottal": laryngoscopic observations of pharyngeal articulations and larynx height" that there was not good evidence for "two distinct places of articulation in the pharynx", i.e. epiglottal and 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 the description of the location of stop stricture being ambiguous). Esling has argued that instead of *place*, distinctions in pharyngeal sounds are a function of *manner* of articulation or a function of *larynx height*. He makes this argument on phonetic grounds. John McCarthy in his paper "The phonetics and phonology of the Semitic pharyngeals" 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 had been described by Laufer and Condax (1981) as phonetically epiglottal, with the epiglottis as the 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.” Continuing he 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 will 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 and 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 and 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 such as those in Figure 1 are not capable of showing the manner of articulation; that must be determined auditorily.

The idea of common pharyngeal-epiglottal linguistic terrain is also reflected in the IPA phonetic symbols. Also in that book, in the new revised symbol tables of the International Phonetic Association there has been a significant increase in the number of recognized sounds in the lower throat to five, so now the IPA now has number 144, a *voiceless pharyngeal fricative* [ħ], number 145, a *voiced pharyngeal fricative or approximant* [ʕ], number 172, a *voiceless epiglottal fricative* [ʜ], number 173, an *epiglottal plosive* [ʡ], and number 174, a voiced epiglottal fricative [ʢ], cf. Handbook of the IPA (1999:163).

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* [ʡəˤɑħ] '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 Scovering of the vocal folds by the ventricular folds cf. Esling and 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

[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.

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 /ʢ/ 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 sphinctering so that the tongue and epiglottis are pressed against the pharyngeal wall. Phonologically, only /ʔ/ and /ʢ/ contrast, and they are implemented phonetically as [ʔ] in *amis* [ʔɑmisː] 'Amis', *kaen* [kɑʔən] 'to eat' or *roma* [romɑʔ] 'other', and are distinct from /ʢ/, which is implemented as [ʢ] initially and medially, and as [ʡ͡ʢʰ] finally, e.g. in *'icep* [ʢtsəpʰ] 'betelnut', *po'ot* [poʢʊtʰ] 'small knife', and *loma'* [ɾumʊʡ͡ʢʰ] '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.

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. Huang Tung-chiou is a speaker of the Hsiukuluan variety of Amis about 50 km south of Hualien from a village called 舞鶴 Wǔhè.

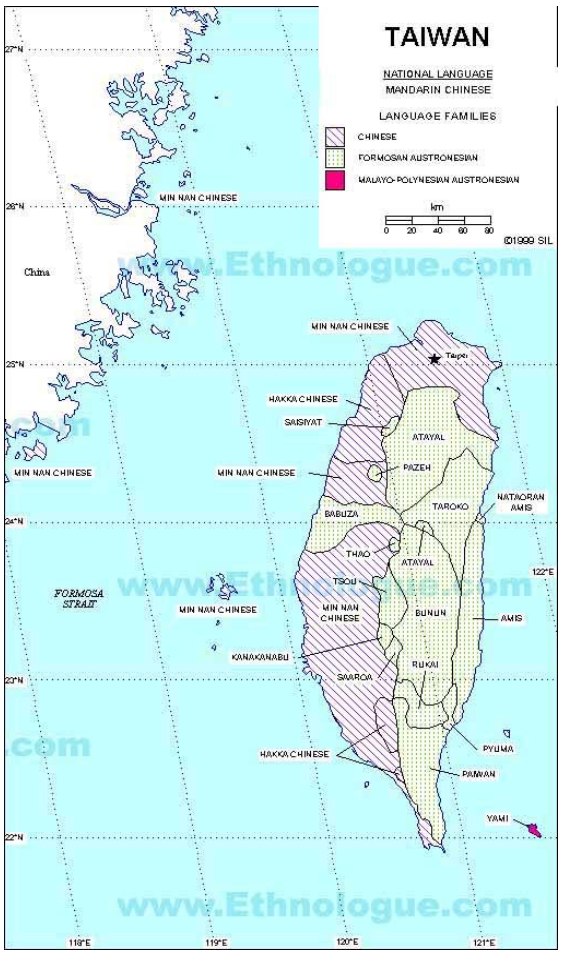
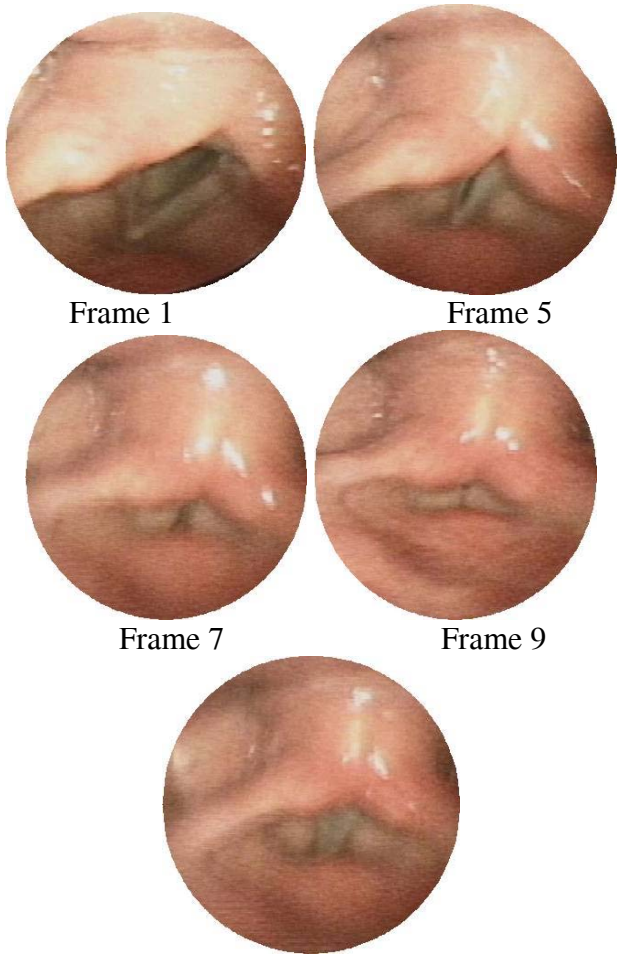


Figure 2: Map of the Amis area

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.



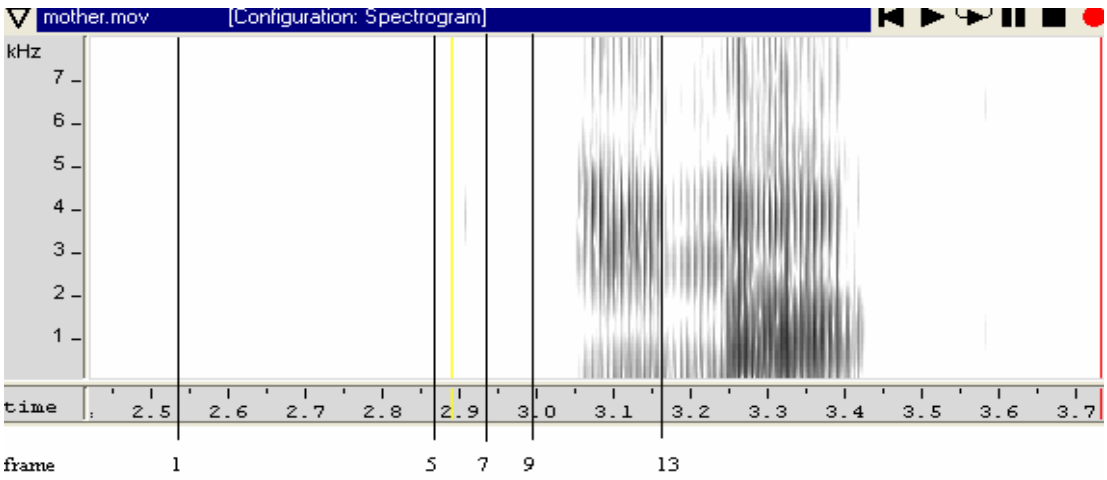
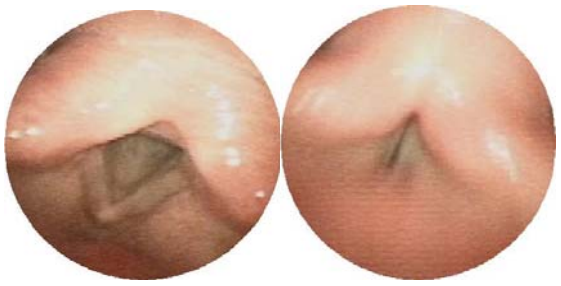


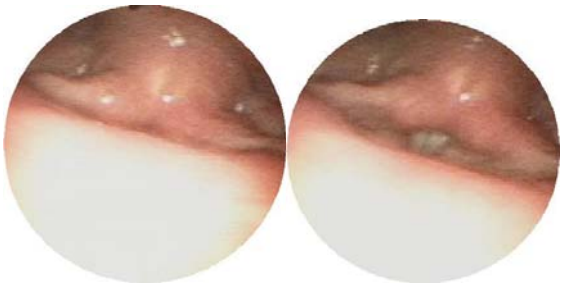
Figure 3: Moderate glottal stop with ventricular incursion in Amis *ina* [ʔinɑʔ] 'mother'

An epiglottal stop occurs at the onset of *'ikong* [ʔikoŋ] '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 under-surface 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

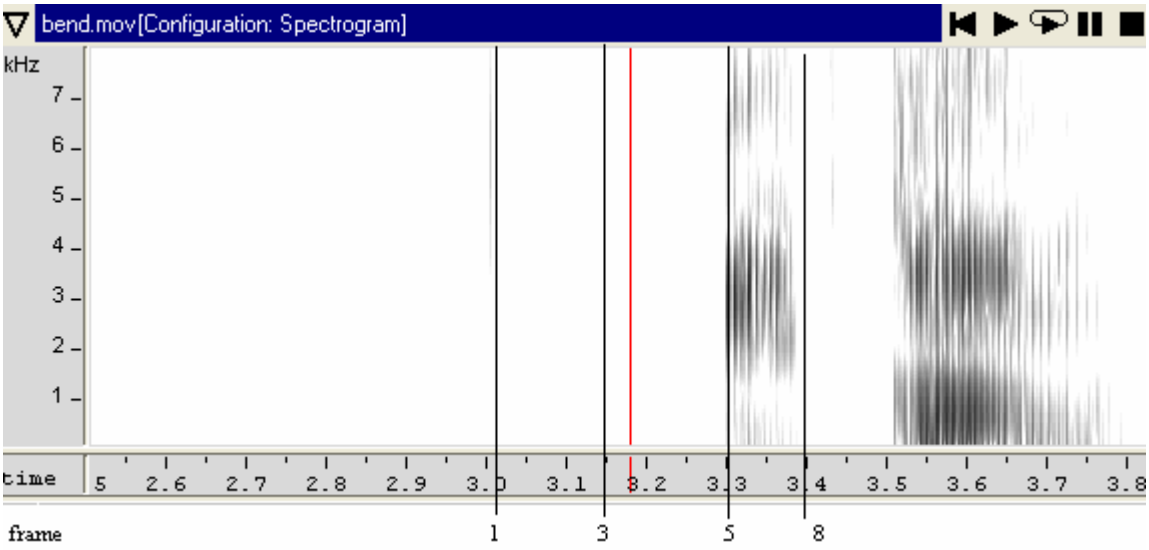
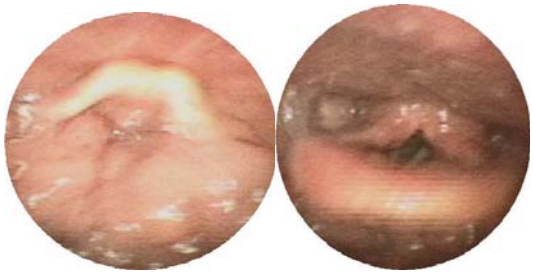


Figure 4: Aryepiglotto-epiglottal stop in Amis *'ikong* [ʔikoŋ] ‘to bend’

The slide sequences in Figures 3 and 4 are in sharp contrast to those from the videos of *riri'* ‘grasshopper’ [riri͡ʔʔʰ]. 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 under-surface (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

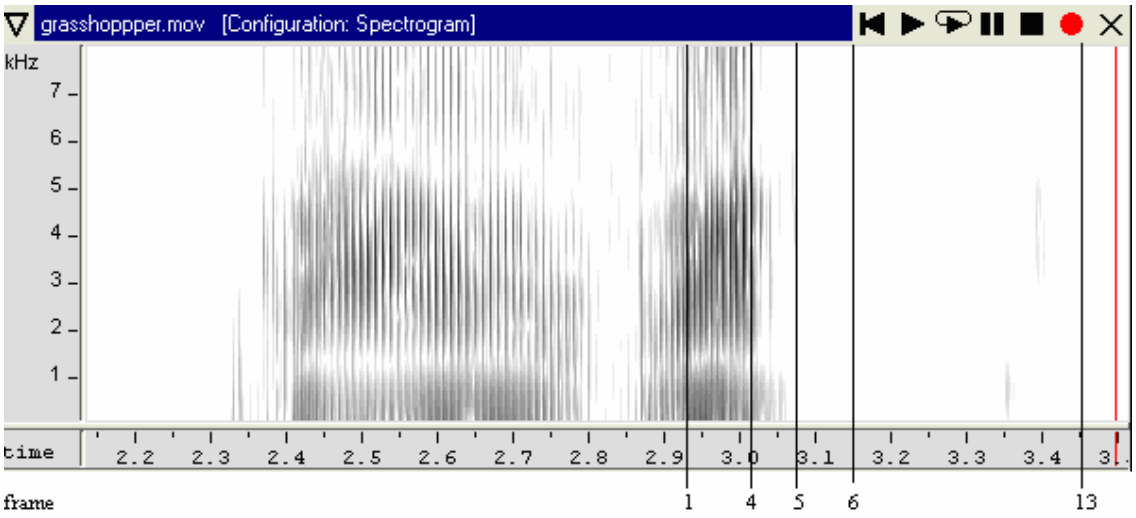


Figure 5: The epiglotto-pharyngeal stop in Amis *riri'* [ririʢʰ] 'grasshopper'

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. Due to the absence to this point, as far as we know, of the reporting of complete epiglotto-pharyngeal stop stricture 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 aryepiglotttic 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 [ʕ͡ʔ] contains within it a glottal stop and an epiglottal stop. In an epiglottal stop [ʢ͡ʡ] 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'.

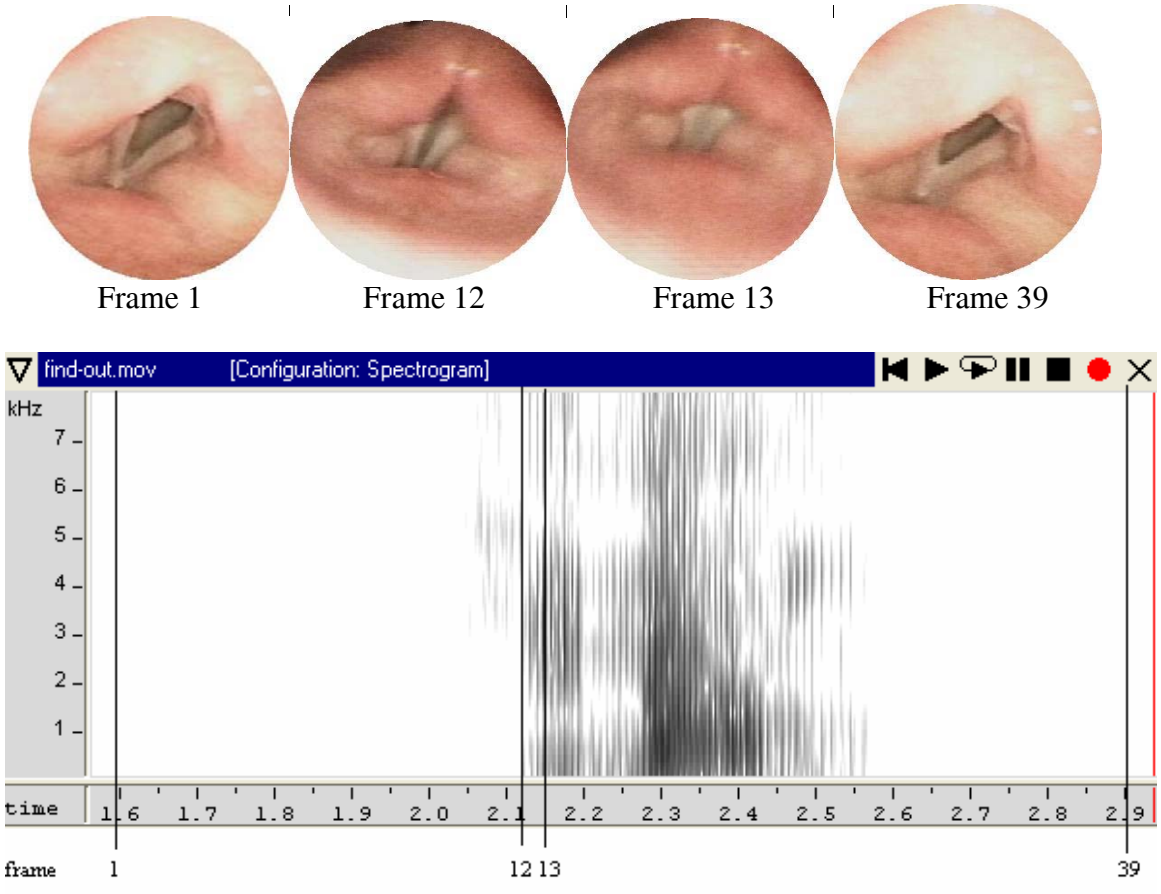
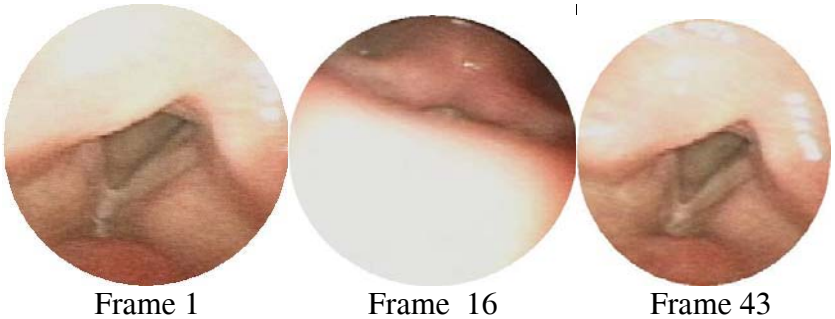


Figure 6: The stages in the production of the glottal fricative [h] in *hinam* [hinam] 'find out'

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* [tiʜiʔ] 'accompany'. It is marked by substantial larynx raising.



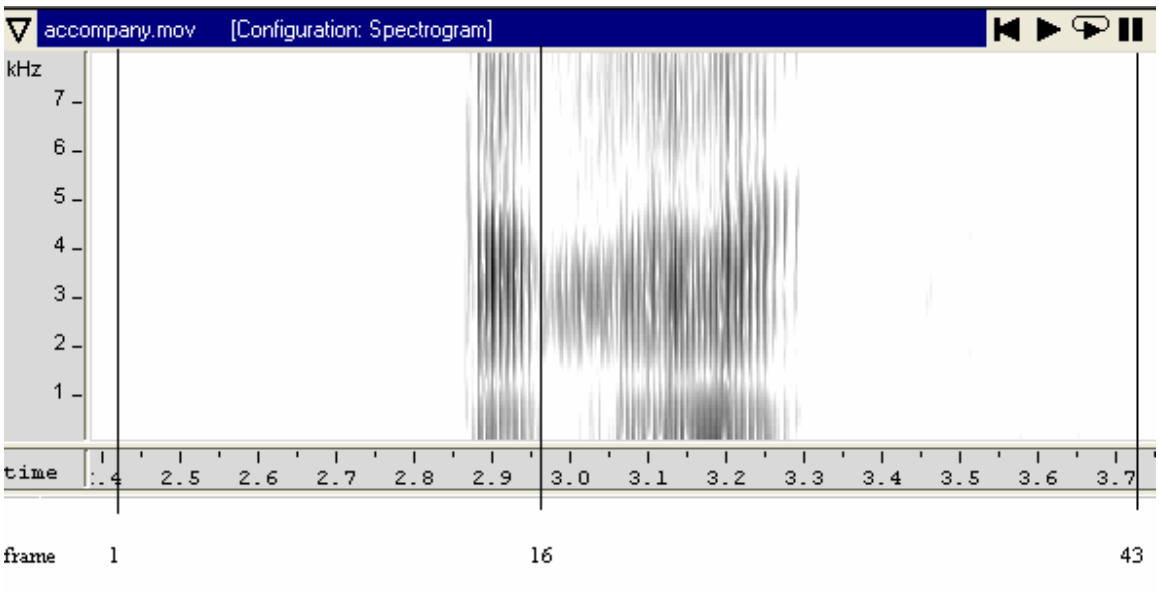


Figure 7: The stages in the production of the epiglottal fricative [ʜ] in [tiʜiʔ] 'accompany'

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.

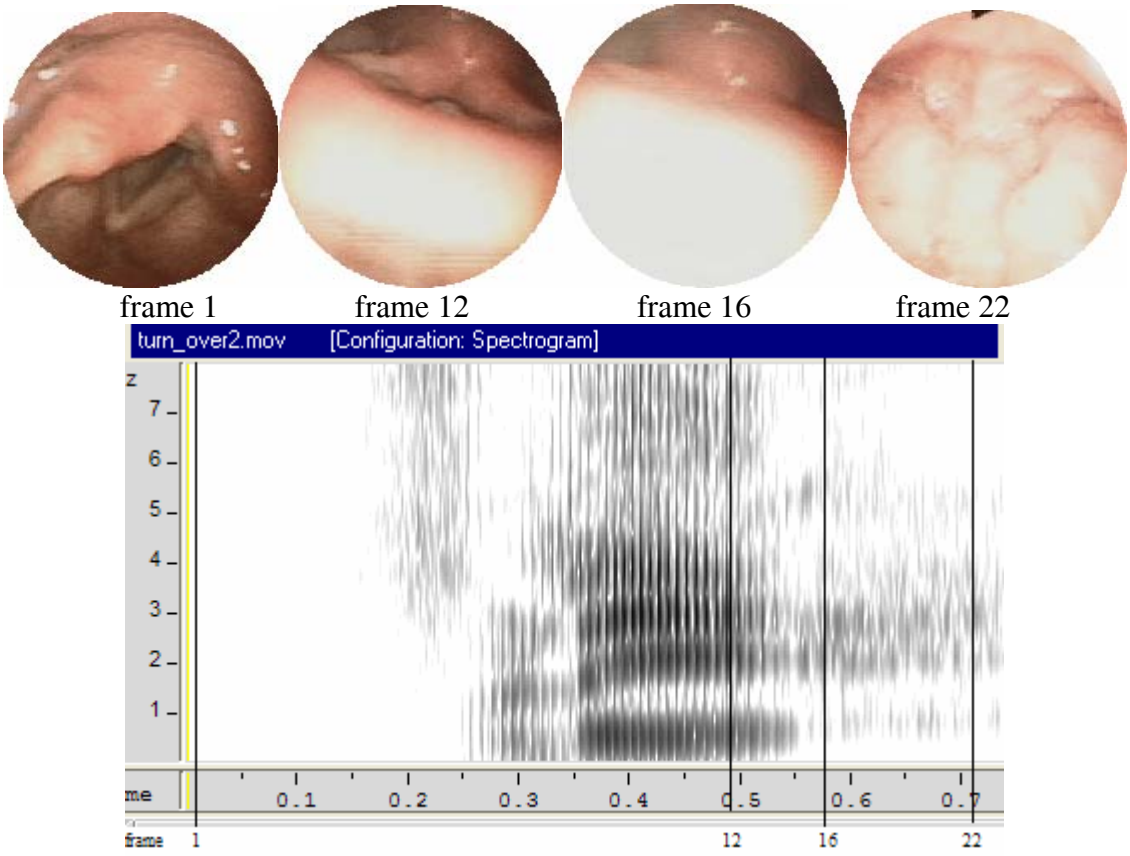


Figure 8: Stages in the production of the pharyngeal fricative in *felih* [fəliħ] 'to turn over'

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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