9	s	laminal closed post-alveolar (hissing-hushing)	Ubykh
10	5	sub-apical palatal (sub-apical retroflex)	Toda

distinction is not necessary (and may even be misleading) for the next possibility, the alveolar sibilant s listed in the second row. As we saw in languages such as English, some speakers have apical s, and others laminal s. But in Toda the alveolar sibilant s is always laminal, and for that reason we have added a specific symbol in the third row of table *5.7*. The next row begins the listing of the post-alveolar sibilants. The sibilants in the fourth row are traditionally called retroflex in descriptions of Chinese and Polish; but they are usually laminal, whereas retroflex consonants of other kinds and in other languages are usually apical. For this reason we call the Polish and Chinese sounds laminal (flat) post-alveolar sibilants, and avoid the term retroflex in their description. There are, however, true retroflex sibilants. Toda might be said to have two retroflex sibilants, an apical post-alveolar s, listed in the fifth row, which contrasts with a sub-apical palatal g, listed in the tenth row.

The domed post-alveolar J in the sixth row can be apical or laminal in English. In Toda, however, it must be laminal. A more specific symbol for the Toda sound can be formed with the laminal diacritic added to the symbol J as shown in the seventh row of table *5.7*. Both the apical and the laminal post-alveolar domed sibilants are sometimes called palato-alveolars, whereas the sibilant in the eighth row, c, maybe called alveolo-palatal. The three sibilants g, f, c differ from one another by increasing amounts of raising of the part of the tongue immediately behind the constriction. The sibilant in the ninth row, s, differs from the others in that the tip of the tongue rests against the lower teeth so that there is no sublingual cavity. The final sibilant in the table, g, is perhaps the most different from all the others from an articulatory point of view, in that it is a sub-apical sound.

5.3 Posterior Non-sibilant Fricatives

Most of the fricatives in the dental, alveolar and post-alveolar regions are of the sibilant, obstacle, type. But, in addition to the non-sibilant alveolar fricatives of the 6

give birth

type that we described earlier, there are also non-sibilant fricatives further back in this region. A non-sibilant apical post-alveolar (retroflex) fricative occurs in some forms of English. This sound, which we symbolize by 4, is the fricative counterpart of the retroflex approximant-j. It is the usual pronunciation of *r* in words such as *red roses* in South African English as spoken in the Eastern Cape. Note that in this dialect^ which is a post-alveolar non-sibilant fricative, contrasts with 3, which is a post-alveolar sibilant fricative, in words such as *drive* vs. *jive.* The non-sibilant fricative 4. differs from the sibilant fricatives z and 3 in the position of the jaw and the shape of the articulatory constriction. The non-sibilant fricative does not have the lower jaw raised so that the teeth are close together; and the constriction is wider so that it does not produce a high velocity jet of air striking an obstacle. A post-alveolar non-sibilant fricative 4. also occurs in some forms of Edo, where it contrasts with an approximant j (Ladefoged 1968). We will illustrate sounds of this type in chapter *7.*

Phonological contrasts involving voiceless palatal fricatives are fairly rare; less than 5% of the languages of the world include c in their inventory (Maddieson 1984a). The voiced palatal fricative j. is even more rare. But the Chadic languages Margi and Bura have - at least on the surface - not only both the voiced and voiceless palatal fricatives c, j. but also contrast these with a voiced approximant j, as well as with voiced and voiceless velar stops, and voiced and voiceless velar fricatives. In the phonology of Margi the palatal fricatives are the palatalized counterparts of the velar fricatives (Maddieson 1987). Margi words illustrating all these sounds are shown in table 5.8. The voiced velar fricative y is often more like an approximant than a true fricative.

It is not clear whether the vocal tract shapes in palatal fricatives are equivalent to the overall shapes in the corresponding stops, with the difference being simply that there is a narrow constriction for the fricatives, and a complete closure for the stops. We do not have any physiological data on these Margi sounds; but x-ray data for other languages indicate that palatal stops and fricatives may differ considerably in the position of the root of the tongue. Figure 5.20, based on x-ray data in Bolla (1980), shows that Hungarian c and j have the root of the tongue more advanced than c and j. This may be because the stops (and the nasal ji) require an articulatory gesture in which the tongue has to be raised considerably higher, as if the aim were to push the tongue through the

Figurr5.20 X-ray tracings of Hungarian palatals (after Bol la 1980). Note that the root of the tongue is more advanced for the stops on the left-hand side, than for the palatal fricatives and j on the right.

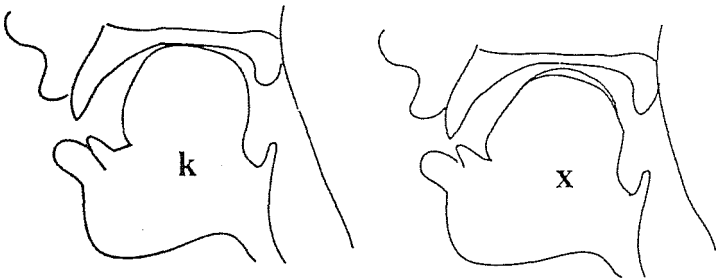

Figure 5.21 A comparison between a voiceless velar stop and a voiceless velar fricative in Standard Chinese (based on data in Zhou and Wu 1963).

roof of the mouth, as we noted in chapter 2.

There are data on several languages containing velar fricatives, indicating that the vocal tract shape is much the same in the stops and in the fricatives. The differences in the overall vocal tract shape are less dramatic than those for the palatal gestures, perhaps because the gesture for a velar stop requires a less extreme tongue movement than that required in palatal stops. A comparison between Standard Chinese x and k (based on data in Zhou and Wu 1963) is shown in figure 5.21.

Velar fricatives contrast with uvular fricatives in a number of languages (e.g. in the

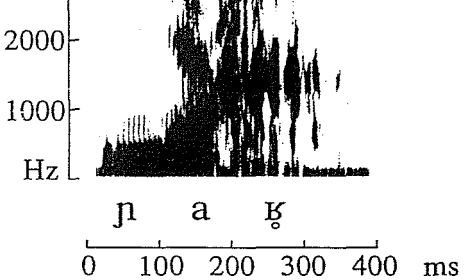

Figure 5.22 Voiceless uvular fricative trill ʁ in Wolof (after Ladefoged 1968).

Amerindian languages Haida, Tlingit, Wintu and Pomo, and in many Caucasian languages). We do not have any articulatory data of our own on any of these languages, but we think it likely that uvular fricatives may have much the same vocal tract shape as uvular stops. There is, however, a complication in the case of uvular fricatives in that the shape of the vocal tract may be such that the uvula vibrates. An example of a trilled uvular fricative in Wolof is presented in figure 5.22. Uvular trills are discussed in chapter 7.

As we noted in chapter 2, pharyngeal fricatives are not as common as might be supposed from the literature, as most of the sounds to which this label is attached (e.g. in Arabic and Hebrew) are actually what we would call epiglottal rather than pharyngeal in place. There is, however, a clear case of a language with a pharyngeal fricative that contrasts with an epiglottal fricative in Agui. Examples of the contrasts in the Burkikhan dialect of Agui were given in table 2.9, repeated here as table 5.9. Spectrograms illustrating these contrasts are shown in figure 5.23. The first and second formants come very close together in the pharyngeal fricative, with the first formant having a very high value (well above 1000 Hz at the maximal pharyngeal position for the fricative). The first formant then falls during the early part of the following vowel. The epiglottal fricative is both noisier (having a greater intensity relative to the surrounding vowels) and more like a simple noise source producing energy in

The sounds in Semitic languages that are called pharyngeal fricatives are often neither pharyngeals nor fricatives (Laufer and Condax 1979, 1981). Catford describes these sounds as approximants; in fact he goes on to say that they are "often wrongly described as fricatives," a sentiment with which we agree. He is clearly correct in saying that in much, if not most, casual colloquial Arabic (as opposed to citation forms produced for the benefit of linguists) these sounds are not fricatives. In our experience there is audible local turbulence in the sound that Catford symbolizes as h, but, as he notes, it is very seldom apparent in what he symbolizes as J.

We would also suggest that these Semitic fricatives might more properly be called epiglottal rather than pharyngeal. Catford (1977b) describes a gesture that we regard as truly pharyngeal in which "the part of the pharynx immediately behind the mouth is laterally compressed, so that the faucal pillars move towards each other. At the same time the larynx may be somewhat raised." He considers this to be "the most common articulation of the pharyngeal approximants." There are, however, several

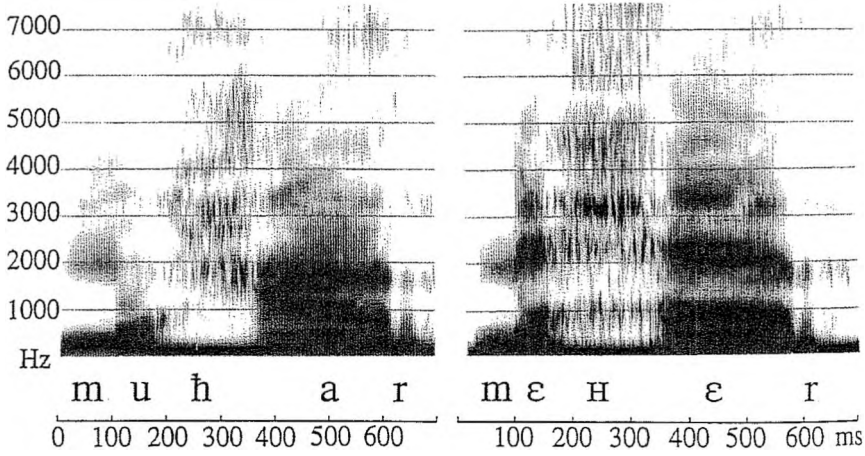

Figure 5.23 Spectrograms of the Agui words muhar 'barns', and merter 'wheys' spoken by a male speaker of the Burkikhan dialect.

Figure 5.24 A voiceless epiglottal fricative ʜ (before u:) in Arabic (from data in Bukshaisha 1985).

instrumental records indicating that these gestures are more usually made in the epiglottal region, rather than in the upper part of the pharynx. A typical gesture as indicated by x-rays is as shown in figure 5.24 (from data in Bukshaisha 1985). The diagrams based on x-rays in Al-Ani (1970) for Iraqi Arabic and Ghazeli (1977) for Tunisian Arabic also show that there is a constriction near the epiglottis. Laufer and Condax (1981), using fiberoptic data, describe a gesture in which the epiglottis has a more active role. In their work on Hebrew (and in later work on Palestinian Arabic, Laufer, personal communication) they conclude that the constriction "in no way involves the tongue." Instead it is "made between the epiglottis and the posterior pharyngeal wall, and may involve contact between the epiglottis and the arytenoids." This may be somewhat of an over-statement in that a more recent x-ray study by Boff Dkhissi (1983) concludes that the movement of the epiglottis is not independent from that of the root of the tongue; rather the two elements work together in forming the constriction. In so far as these sounds are epiglottal rather than pharyngeal fricatives, they might better be symbolized ʜ, 5, rather thanh, Y.

Gestures involving the epiglottis occur in a number of other languages, in addition to the Semitic languages discussed above. We noted above and in chapter 2 that the Burkikhan dialect of Agui contrasts these sounds with pharyngeal fricatives. Catford (1983) says that this language "has no fewer than seven pharyngeal and laryngeal sounds: pharyngeal h and 5, 'deep pharyngeal' [which we would call epiglottal] or 'emphatic' ʜ, ?, and the corresponding stop?, and glottal h and?." There are x-ray studies of some of these fricatives in other Caucasian languages. Figure 5.25 shows tracings (also reproduced by Catford) from x-rays by Gaprindashvili (1966) and Bgazhba (1964) showing the difference between fricatives in the epiglottal region in Dargi and in the middle or upper part of the pharynx in Abkhaz.

It may be that, instead of two distinct regions, pharyngeal and epiglottal, there is actually a range of possible gestures made in this one general area. The most anterior of these would be the gestures described by Catford (1977b) as involving the faucal pillars and the part of the pharynx immediately behind the oral cavity. A slightly more

Figure 5.25 Upper pharyngeal constrictions (extending into the uvular region) in Abkhaz (top row, based on Bgazhba 1964), and epiglottal constrictions in Dargi (bottom row, based on Gaprindashvili 1966).

retracted gesture can be exemplified by Danish *r*. This sound is sometimes considered (e.g. by the International Phonetic Association 1949) to be a form of uvular ʁ, but it actually involves a weak constriction much nearer to the middle of the pharyngeal continuum. In contemporary Danish these sounds are usually approximants rather than fricatives, but in a very distinct, more old-fashioned, pronunciation a turbulent airstream is formed in the vicinity of the constriction associated with a low back vowel. This is closer to the glottis than the constriction near the faucal pillars in the upper part of the pharynx described by Catford (1977b), but it is distinctly above the level of the epiglottis.

Gestures involving constrictions that may be even closer to the larynx occur in Khoisan languages, where they are used in the production of so-called 'strident' vowel sounds (Ladefoged and Traill 1984, Traill 1985). There are phonological and phonetic reasons for considering these Khoisan gestures as phonation types rather than as fricatives of the kind we have been considering in this chapter. They are additive components that affect the vowels rather than forming in themselves a consonantal gesture; and they often involve a concomitant laryngeal gesture. Nevertheless they are definitely fricative sounds, with a turbulent airstream being produced by a constriction within the vocal tract, just above the vocal cords. X-ray tracings (from Traill 1985) showing the articulations used by two speakers of !X66 are given in figure 5.26. Traill notes that the epiglottis is hard to specify in these tracings from frames in a cine-x-ray film, as it was usually vibrating. Accordingly it might be appropriate to describe these sounds as epiglottal fricative trills.

Figure 5.26 X-ray tracings of two speakers of 1X66 producing epiglottal articulations accompanying vowels of an u type (dotted line) and of an a type (solid line) (after Traill 1985).

Finally in this survey of possible fricative gestures, we must consider some more complicated possibilities. Shona has so-called 'whistling fricatives' in which there is extreme lip rounding combined with a laminal alveolar gesture. These sounds are discussed further in chapter 10, when we consider multiple articulations. Some dialects of Swedish have a fricative that has been said to have two or even three articulatory constrictions (Abercrombie 1967). We do not, however, think it is correct for more than one of these constrictions to be considered a fricative articulation. There is good data available on the Swedish sibilant fricatives (Lindblad 1980) allowing us to consider these sounds in detail.

Swedish has four phonologically distinct fricative gestures. The contrasting sounds are sometimes symbolized f, s, c, fj; in addition, in Standard Swedish, there is a retroflex fricative g, which is, phonologically, the sequence /rs/. The first two of these, f, s, do not need extensive comment; f is labiodental f, and s is dental s. The other two, c, fj; are more difficult to describe. The basic descriptive problem is one of geographical, social, and stylistic variation. According to Lindblad (1980), the most common usage is fore to be a "predorsoalveolar fricative." His further comments and sketches based on x-rays indicate that c is similar to the Polish gesture that we symbolized in the same way, which we called a palatalized post-alveolar sibilant. Lindblad notes that variations of this phoneme in Swedish include an affricate tc or tf, and a palatal fricative c similar to that in German *ich*.

The fourth Swedish fricative, usually symbolized by 5, is the most interesting. Lindblad describes two common variants of Swedish fj. The first, for which he uses a different symbol, he calls a highly rounded, labiodental, velar or velarized fricative. A redrawn version of his x-ray tracing is shown in figure 5.27. Lindblad suggests that the source of friction is between the lower lip and the upper teeth, and it certainly appears to be so from his x-ray. He also demonstrates that the upper lip is considerably' protruded in comparison with its position with that in the gesture for i. In addition to these

Figure 5.28 Lindblad's (1980) pronunciation of an alternative form of Swedish § on the left, and his pronunciation of German x on the right.

anterior gestures, Lindblad notes that the "tongue body is reused and retracted towards the velum to form a fairly narrow constriction. (The presence of this constriction is constant, but not its width or location, which vary considerably.)" The posterior constriction in this variety of fj is riot great enough to be itself a source of turbulence, so that, although this sound may have three notable constrictions, one in the velar region, one labiodental, and a lesser one between the two lips, only the labiodental constriction is a source of friction.

The second common variant *of* Swedish fj, illustrated in figure 5.28, is described by Lindblad as a "dorsovelar voiceless fricative" pronounced with the jaw more open and without the lip protrusion that occurs in the other variety. Lindblad suggests that the difference between this sound and the more usual velar fricative x is that the latter "is formed with low frequency irregular vibrations in the saliva at the constriction" (Lindblad 1980, our translation). We infer from his descriptions and diagrams that this variant of fj has less friction, and may be slightly further forward than the velar fricative x commonly found in o ther languages. Lindblad claims that between the extreme positions of the labiodental fj and the more velar fj, "there are a number of intermediate types with various jaw and lip positions, including some with both anterior and posterior sound sources." As we note in chapter 10, we doubt that it is possible to produce turbulence at two points in the mouth simultaneously for ordinary linguistic purposes.

Halle found very varied spectral characteristics for f, v, but more specific spectral properties for the sibilants, with s, z being characterized by spectral peaks at higher frequencies than J) 3. In their more recent study, Shadle, Moulinier, Dobelke and Scully (1992) come to a similar conclusion. Hughes and Halle (1956) did not investigate English 0, 3, and there is still a lack of published acoustic data on these sounds, with only small amounts of data having been reported by Shadle et al. (1992). It seems that in the case of the pairs f, 0 and v, 3 in English, the inconsistencies between speakers are so great that it may be profitless to try to characterize the acoustic spectra of the fricatives themselves. Shadle et al. (1992) note that the generally accepted view is still that of Harris (1958) who suggested that the principal difference between these fricatives lies in the formant transitions.

Lindblad (1980), whose articulatory investigations of Swedish fricatives were described above, also provided two different kinds of acoustic data on Swedish fricatives. One is the analysis of a subset of these fricatives as they occur in different phonetic contexts, and as spoken by different individuals. The other is an analysis of a wider range of Swedish fricatives as spoken by himself as an illustration of archetypal productions ('cardinal' versions) of these sounds. His analysis ofs, c ands as spoken by five different speakers is reproduced here in a slightly modified form in figure 5.29. There are large variations among the speakers, but it is true that for each of them? has the lowest cut-off frequency, c the next, and s the highest. There are also very considerable contextual effects, as maybe seen from figure 5.30, which shows these same fricatives as pronounced by two of the speakers in a variety of vowel contexts. For any one vowel context the spectral relations among s, c, s are similar to those described above when they occurred before a:. But the variations in the spectrum of each of these fricatives before different vowels are enormous. Figures 5.29 and 5.30 provide good evidence of the difficulty of characterizing fricatives in terms of their spectra.

Lindblad's demonstrations of his own pronunciations of some of the fricatives that occur in different Swedish dialects are shown in figure 5.31. He notes that these sounds maybe characterized to a great extent by the frequency of the lower edge of the band of fricative noise. For the three sibilants s, g, J on the left of the figure, this frequency gradually descends. (It is somewhat surprising that it should be lower in J, than ing.) In the palatalized post-alveolar sibilant c in the lower left of the figure there is a less