

Few data are available on reproduction and life histories. Kimberley species, which live in an area with a predictable and dependable summer wet season that lasts four to seven months, are protandrous hermaphrodites with a maturation pattern characterised by several features (Solem & Christensen 1984). They reach half adult size in the wet season of birth. They complete shell growth and become male mature near the end of the second wet season, and are male active throughout the third wet season. They become female mature late in the third wet season, and are male and female active during fourth and successive wet seasons. They have a life span of at least eight, probably more than 10, years in all.

There are clear patterns of seasonality for adult organ size in the Kimberley taxa. Species from central Australia and the Flinders Ranges of South Australia also are protandrous hermaphrodites, but full sexual maturation precedes completion of shell growth, the length of life probably extends to 20 or more years, and size variation in adult organs is reduced because there is no dependable wet season. Taxa from the near desert regions show additional modifications in structure (Solem 1992, 1993). The one significant report on reproduction in the eastern Australian taxa (McLauchlan 1951) contains a number of significant observations and several hypotheses on mating, egg laying and life expectancy that need to be tested.

Aestivating snails may burrow into the sand or soil, lie loose in generally shaded litter or rock talus, or seal the shell aperture to a rock, piece of wood, or another snail shell. Those that seal to objects use a strengthened mucus, which may be so strong that the shell itself breaks first when an attempt is made to pull the shell loose. The calcified whole-aperture epiphragms are unusual in that gas exchange may take place around the edge of the epiphragm, rather than through a breathing pore (Solem 1986b).

A few wet area camaenids may become garden nuisances by feeding on ornamental plants, but otherwise they are not known to be of economic importance.

Camaenids are common and diverse from South-East Asia to Japan, the Philippines, Indonesia, and through New Guinea to the Solomon Islands. In the New World, they extend presently from the Greater Antilles and Costa Rica south to Bolivia. A moderate Cretaceous to Miocene fossil record in the United States (Solem 1978b) indicates a northern origin and a subsequent loss of northern range area. In Australia, camaenids apparently never reached, or were unable to colonise, either the humid south-western portion of Western Australia or Tasmania and the wetter parts of Victoria. The Kimberley and immediately adjacent areas of the Northern Territory have the largest camaenid fauna in Australia – about 185 species in 23 genera, of which 14 genera and all 185 species are endemics with restricted distributions. Very few Australian fossil camaenids are known, but Ludbrook (1978, 1984) and McMichael (1968) have published some records. Most published records are based upon incomplete casts that are difficult to interpret.

Superfamily HELICOIDEA

The helicoidean shell is small to very large (up to 100 mm in height), and usually helicoid in shape. However, the variations in shape are great and range from discoidal to turreted, rarely lenticular or often ovate-conic. The aperture is generally large and infrequently contains lamellae and denticles. Shell sculpture varies from smooth to strongly costulate, sometimes with additional periostracal elements. Shell colour ranges from drab brown to brightly coloured. The peristome is usually thickened and reflected. The form of the radula is variable but the basic pattern of weakly tricuspidate central teeth, bicuspidate lateral teeth and multicuspitate marginal teeth underlies a wide range of habitat-related modifications. The jaw may be smooth or ribbed (Pilsbry 1939).

The length of the kidney is variable and the ureter is sigmurethrous. The complex reproductive system includes dart sacs, accessory glands and other appendages. An epiphallus is present on the penis. Helicoideans are oviparous or ovoviviparous.

None of the three families included is native to Australia. However, two are represented by introduced species. The Helminthoglyptidae are a New World family widely distributed in North and South America and the West Indies. The Bradybaenidae are basically an Eurasian family, that includes some brightly coloured species from the Philippines. A widespread introduced species, *Bradybaena similaris*, is present in Australia. The Helicidae are a western Palaearctic group and include many species that have been spread widely by humans. A number of helcid species are now resident in Australia.

The Helicoidea includes the most advanced pulmonates and dates from the Cretaceous–Palaeocene of Europe and North America (Solem 1979a).

Family Helicidae

The Helicidae are a large family of terrestrial snails with globose, subglobose or conic shells. The family is native to the Palaearctic Region of Europe, western Asia and North Africa but a number of species are accomplished world travellers (Smith 1989) and have become well established, and even dominant, in many temperate regions of the world. Eleven species have been introduced, mainly accidentally, into Australia with the European settlement of the continent (Smith 1992) and most have quickly become serious pests of gardens and crops. Petterd (1879b) recorded that *Helix aspersa* was introduced intentionally into Tasmania to provide food for introduced European birds such as the Thrush and Blackbird. These introductions have been documented by Musson (1890), Cotton (1954) and Smith & Kershaw (1979), and the extent of the problems caused by the introductions has been outlined by G.H. Baker (1986, 1988) and G.H. Baker & Vogelzang (1988).

The shells are dextral and vary in form from discoidal to subglobose, globose, and turreted to conic with an elevated spire (Fig. 17.71A–C). Shell size ranges from small to large (up to 60 mm in length). The shells are usually umbilicated and unicoloured but often with spiral bands or axial flammulations. The aperture is usually rounded, and lacks teeth or lamellae and the peristome is simple or reflected. The shell may be sculptured by growth lines, ripples, spiral striae and rugosities. The foot is fleshy and the sole is not discoidal.

Most helicids are herbivorous, feeding on living plants; a few feed on decaying plant material. The jaws are ribbed, plaited or costulate, rarely smooth, and the radula has many small, simple teeth in straight rows (Fig. 17.71E). The crop is large and the digestive tract is long. The length of the kidney varies from short to long and narrow in different groups.

Helicids are protandric hermaphrodites and usually have a dart sac and dart apparatus (Fig. 17.71D). The penis has a papilla or short verge and is continued into an epiphallus usually with a flagellum. Different subgroups vary in details of anatomical features of the reproductive system, such as the dart structures and the form of the spermatheca. Some groups are ovoviviparous but the majority lay hard-shelled eggs.

Helicids are the most widely studied group of land snails with regard to morphology, natural history, ecology and physiology (Baker, G.H. 1986). Some recent work has been done on the effects of Australian conditions on several species (Pomeroy & Laws 1967; Baker, G.H. 1986, 1988; Baker, G.H. & Vogelzang 1988). Mating occurs in early spring. Usually several clutches of white, hard-shelled eggs are laid in damp soil. Under favourable conditions of food and moisture, maturity can be reached in one year and breeding occurs. Some species seek shelter in cool, damp places where they secrete thick mucous epiphragms and aestivate over hot dry periods. Others, for example, *Cernuella* and *Theba* species, aestivate over the hot dry summers of South Australia and western Victoria above ground in very exposed places, such as on wooden posts (Fig. 17.71F; Smith 1981).

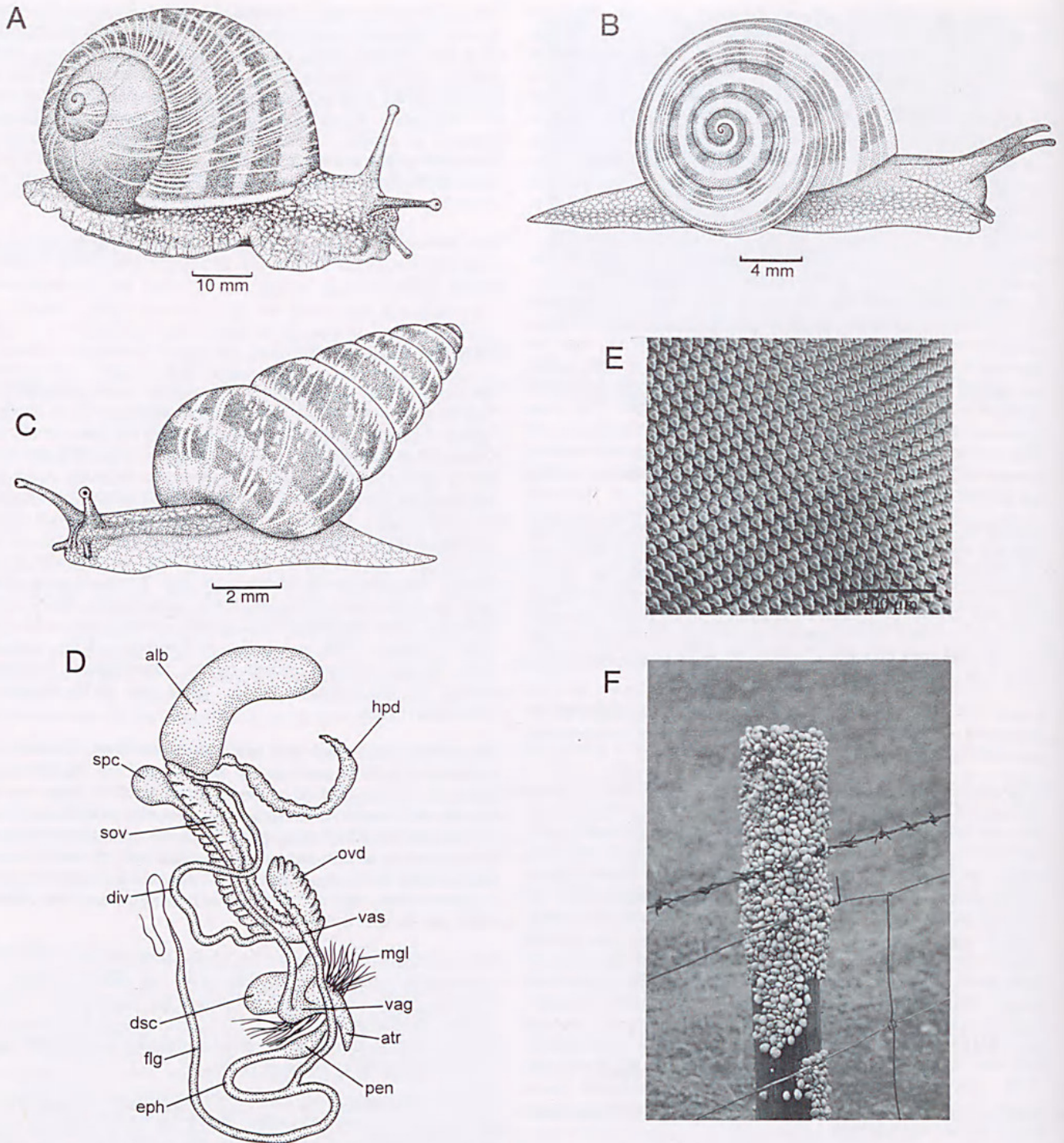


Figure 17.71 Family Helicidae. This family is represented in Australia by introduced species. A, *Helix aspersa*, a widespread garden pest. B, *Theba pisana* may attain high densities in the coastal sand-dunes of southern Australia. C, *Cochlicella barbara*. D, *Helix aspersa*, reproductive tract. E, *Helix aspersa*, portion of radula; F, *Theba pisana*, aestivating on a wooden fence post. alb, albumen gland; atr, atrium; div, diverticulum of spermathecal duct; dsc, dart sac; eph, epiphallus; flg, flagellum; hpd, hermaphroditic duct; mgl, mucous gland; ovd, oviduct; pen, penis; sov, spermoviduct; spc, spermatheca; vag, vagina; vas, vas deferens. (A, C, after photograph by B.J. Smith; B, drawn from live animals collected in Victoria; D, modified after Kerney & Cameron 1979)

[A–D, C. Eadie; E, B.J. Smith; F, G. Baker]

Helix aspersa, *Theba pisana* and species of *Cochlicella* and *Cernuella* are considered pests of gardens, pasture, orchards and stored crops in many parts of southern and eastern Australia (Smith 1981; Baker, G.H. 1986). They are confined mostly to the modified environments of southern Australia, particularly where watering and the cultivation of introduced plants provide favourable conditions, though *Theba pisana* is also found in semi-arid areas such as coastal dunes (Smith 1967b). They are not associated with any animal or human health problems. *Helix pomatia* and *H. aspersa* are widely used for human consumption in Europe, particularly France and Spain. Imported canned *H. pomatia* is available in Australia, and live snails are

occasionally seized by Quarantine Officers at international airports while being smuggled in as food and/or breeding stock. *Helix aspersa* is bred commercially for the table in several parts of southern Australia.

Following H.B. Baker (1956), Burch (1976b) suggested that the Australian species in the group treated here as the family Helicidae should in fact be separated into two families, the Helicidae and the Hygromiidae or Helicellidae. However, they are here treated as subfamilies of the one family, Helicidae, following Zilch (1959) and others. This is one of the largest of land snail families with over 300 named genera (Zilch 1959).



Smith, Brian J. 1998. "Pulmonata: Family Helicoidea." *Mollusca: The Southern Synthesis [Fauna of Australia. Vol. 5]* 5, 1113–1114.

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