unicuspidate or tricuspidate central teeth, tricuspidate lateral teeth and multicuspidate marginal teeth, mounted on distinctly elongate basal plates (Kershaw 1987b; Daniell 1991). The kidney is somewhat oblong. The eyes are situated on long optic tentacles which have very wide bases. The inferior sensory tentacles are also long with wide fleshy bases.

Individuals are protandric hermaphrodites, and animals alternate as male and female during copulation (Daniell 1991). There is no flagellum or dart sac but the vas deferens expands into an epiphallus (Fig. 17.64B). The talon, or seminal receptacle, consists of two simple lobes adjacent to the globular ovotestis (Kershaw 1987b). These lobes swell with sexual maturity. Mating occurs in spring and summer. The oviducal pore is elongated in *Cystopelta petterdi* forming a cone-shaped process which is used to stroke the penis of the partner. Sperm are transferred in a simple spermatophore. The small spherical, almost transparent, eggs are laid scattered singly under or inside rotting logs in both spring and autumn. Hatching is thought to occur within 10–20 days under favourable conditions (Daniell 1991).

Cystopeltids are found in forest areas, usually in damp conditions but can be found in wet and dry sclerophyll forest and in alpine snow-gum woodland. They are semi-arboreal and readily climb up the trunks of trees in damp or wet conditions (usually only at night). They seek shelter under logs and in the litter and loose soil in drier conditions. Many forms appear to be cryptically coloured, with a light and dark mottled appearance which closely resembles the tree trunk on which they are observed. Under favourable conditions, large populations have been observed active on trees, particularly in Victoria and Tasmania (Allan 1950; Smith 1980) and the Blue Mountains, New South Wales (W.F. Ponder personal communication). The animals are thought to feed on the minute lichens and bacterial film on tree trunks (Daniell 1991). The faeces are ejected in a characteristic ribbon coil (Fig. 17.64C), and their presence on tree trunks indicates occurrence of these animals in an area. Animals often seek shelter in the long coiled streamers of free-hanging bark in wet eucalypt forests.

The main predators are probably birds and rhytidid snails (Smith 1980). Feeding is a nocturnal activity under wet conditions in dry forests, but in dense wet forests the animals are active during the day. The animal secretes a green caudal mucus when the foot is irritated. Observations suggest that the colour of both mucus and foot may vary with the season, age and vegetation type. The mucus secreted by cystopeltids fluoresces under ultra-violet light (Daniell 1991), but neither its function nor its significance is known.

This endemic family is confined to eastern Australia, from Tasmania to southern Queensland. *Cystopelta* is the only genus in the family. Two species are recorded from Tasmania (*C. bicolor* and *C. petterdi*), one from southern New South Wales and Victoria (*C. astra*) and one from Queensland to Victoria (*C. purpurea*) (Iredale 1937b; Smith 1992). Daniell (1991, 1994) implied that more species are yet to be described.

The affinities of the family to other molluscan groups are uncertain (Kershaw 1987b). Hedley (1893) compared the animal of a *Cystopelta* species, with the helicarionid *Parmacochlea fischeri*. Bishop (1981) stated that a derivation from a helicarionid is unlikely. The ureter is much modified and is not obviously sigmurethran. However, a sigmurethran ancestor seems most probable (see Solem 1978a for discussion). Based on similarities in the structure of the digestive and nervous systems, Tillier (1989) aligned the family more closely with the Endodontoidea.

Family Testacellidae

Testacellids are very unusual slugs, which are easily recognised by the elongate slug-like body and the small, auriculiform shell on the posterior end (Fig. 17.65A). The family is native to western Europe but has been introduced accidentally into many parts of the temperate world, including southern Australia (Smith & Kershaw 1979; Smith 1989). A detailed description was given by Quick (1960).

The sub-cylindrical body tapers towards the anterior end and extends to about 130 mm in length. The shell, located at the posterior extremity, is reduced to an oval to auriculiform remnant about 10 mm in length with a tiny, posteriorly pointing apex. The small mantle is situated posteriorly and covers a portion of the shell. Two grooves lead forward from the mantle on the upper lateral surfaces from which oblique side branches descend on each side. These are thought to be concerned with mucous secretion, possibly associated with feeding. The foot is aulacopodous with peripedal furrows but lacks a caudal mucous pit or gland. The pedal gland is free in the body cavity. The pericardium is on the right side of the kidney with the ventricle in front of the auricle. The kidney lacks a distal secondary ureter, and the primary ureter opens deep in the pulmonary cavity.

Testacellids are carnivorous and prey on earthworms which they grasp rapidly with the radula and smother with body mucus. The prey is ingested rapidly. Most of the features of the alimentary system and many of the general body features are adaptations to the carnivorous habit. These include the absence of jaws, the large, muscular buccal mass with a modified radula, the short and simple digestive tract. The posterior location of the respiratory opening provides for a long, unrestricted head region. The radula consists of about 50 sharp V-shaped rows of teeth (Fig. 17.65C). The teeth are simple and lanceolate. The central tooth is weak or absent. The lateral teeth increase in size laterally, reaching a maximum after some 10 to 12 teeth from the centre, and declining in size through the marginal teeth (Quick 1960). This pattern is very similar to the arrangements in other unrelated carnivorous groups (Smith 1987).

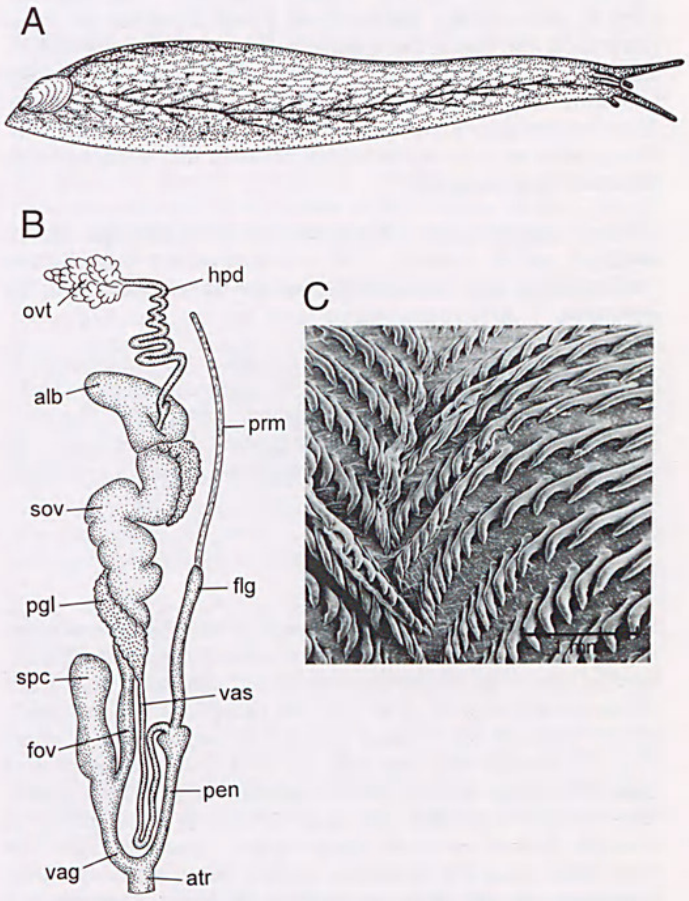

Figure 17.65 Family Testacellidae. *Testacella haliotidea*: **A**, crawling animal showing the reduced, posteriorly placed shell; **B**, reproductive tract; **C**, portion of radula. **alb**, albumen gland; **atr**, atrium; **flg**, flagellum; **fov**, free oviduct; **hpd**, hermaphroditic duct; **ovt**, ovotestis; **pen**, penis; **pgl**, prostate gland; **prm**, penial retractor muscle; **sov**, spermoviduct; **spc**, spermatheca; **vag**, vagina; **vas**, vas deferens. (A, after Kerney & Cameron 1979; B, after Quick 1960) [A, B, C. Eadie; C, B.J. Smith]

Testacellids are protandric hermaphrodites. The thin, elongate penis has a flagellum and a well-developed retractor muscle (Fig. 17.65B). A short duct is sometimes seen between the penis and vagina and is thought to facilitate self-fertilisation. The eggs are large and ellipsoidal (7 x 4 mm in *T. haliotidea*), with a calcareous shell. They are laid in batches of two to 14 eggs and take four to five months to hatch (Quick 1960).

Individuals spend much of their lives burrowing in moist soils of high organic content, where their prey are plentiful. For this reason they are associated with gardens and are seldom seen. They have little economic significance because they are comparatively rare. Nevertheless, they appear to have the adaptability to be successful world travellers (Smith 1989). The family contains only one genus, *Testacella*, with about five or six species. Several of these have been introduced into various parts of the world. Only one species, *Testacella haliotidea*, is confirmed for Australia (Smith & Kershaw 1979) and this has only been recorded occasionally from the main population centres of Sydney, Melbourne and Hobart.

Superfamily SUCCINEOIDEA

The position of the two morphologically distinct families included in the Succineoidea among the Sigmurethra has yet to be unequivocally established. These families – the Succineidae and Athoracophoridae – have often been placed in their own ordinal divisions, the Heterurethra and Tracheopulmonata, respectively. Solem (1978a) thought that the Succineidae were Sigmurethra with a peculiar habitat, and that the aberrant tracheopulmonate slugs of the Athoracophoridae were sigmurethrans that became 'weirdly sluggish'. Their relationships to other shelled sigmurethran groups have not yet been determined and hence the grouping under a single superfamily should be regarded more as one of convenience rather than indicating any close kinship. Tillier (1989) considered the Athoracophoridae to be an endodontoid family and placed the Succineidae with the Achatinoidea, however this arrangement is not universally accepted.

The two families are characterised by their peculiar, highly modified pallial cavities, their unusual ureter and kidney configurations and their elasmognathous jaws. Both occur in Australia.

The Athoracophoridae are large slugs without an external shell (Fig. 1.61D). They are restricted to Queensland, New South Wales, Papua New Guinea, the Bismarck Archipelago, Vanuatu, New Caledonia and New Zealand. In contrast, the Succineidae are a cosmopolitan family of small thin-shelled molluscs associated with moist habitats (Solem 1959a).

Family Succineidae

Succineid snails often are associated with marshes and swamps in wetter climates, and they live near waterfalls on many Pacific Islands. They also inhabit sand dunes and seasonally dry stream banks in many regions. With very few exceptions, the shell has a greatly reduced whorl count and a very capacious last whorl (Fig. 17.66A, B). In a few taxa, the shell is reduced to an oval plate and is much smaller than the animal. The shell lip is always thin and not expanded. The shell usually is light yellow or greenish horn in colour in wetter areas; it becomes lighter or even white under dry conditions. Usually the snail's body can be withdrawn into the shell, except when the latter is reduced to a fragment. Some succineids are semi-slugs with their shells reduced; some species have shells that resemble a small plate. The head and neck are very short, a state reflected in structural changes to several organ systems, as summarised by Solem (1978a). Frequently the body and/or the mantle has conspicuous black markings. The jaw is elasmognathous, with a greatly enlarged attachment plate.

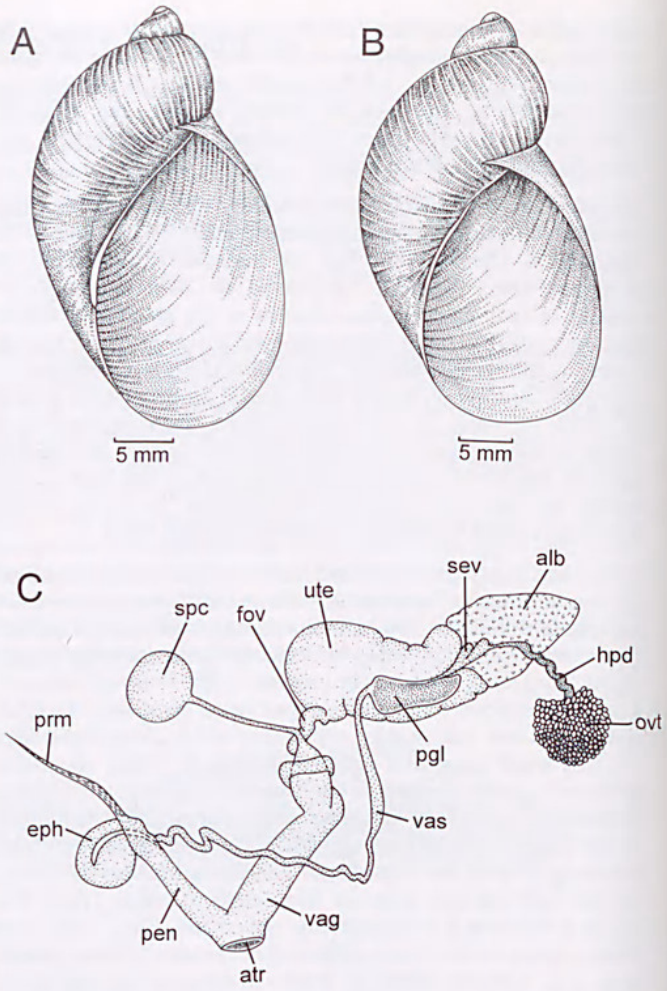

Figure 17.66 Family Succineidae. **A, B**, shells, apertural view: **A**, *Succinea scalarina*; **B**, *Succinea australis*. **C**, *Succinea ovalis*, reproductive tract. **alb**, albumen gland; **atr**, atrium; **eph**, epiphallus; **fov**, free oviduct; **hpd**, hermaphroditic duct; **ovt**, ovotestis; **pen**, penis; **pgl**, prostate gland; **prm**, penial retractor muscle; **sev**, seminal vesicle; **spc**, spermatheca; **ute**, uterus; **vag**, vagina; **vas**, vas deferens. (C, after Solem 1976)
[A, B, R. Plant; C, C. Eadie]

No comprehensive monograph of the Succineidae exists. Patterson (1971) gave a synoptic review of genera, but did not work directly with Australian taxa. A number of Australian species and two genera, *Austrosuccinea* and *Arborcinea*, have been named (Iredale 1937a, 1939), and there have been few subsequent listings in faunistic reports (summarised in Solem 1988b). North American taxa have been reviewed by Pilsbry (1948) and Hoagland & Davis (1987). Quick (1933, 1936) presented anatomical data on British and African species, respectively; the reproductive anatomy of a succineid, *Succinea ovalis*, is illustrated in Figure 17.66C. Though a number of Australian endemic species probably exist, none have been defined and diagnosed adequately. Smith (1992) listed seven species in the genus *Succinea* from Australia, including *S. norfolkensis* from Norfolk Island.

The Australian distribution of succineids is sporadic, with a surprising abundance of colonies in central Australia, the Gawler Ranges of South Australia, and occasionally in Western Australia. They are common in both Victoria and Tasmania.

Powell (1950) provided extensive details on the life history of the New Zealand *Austrosuccinea archeyi*. However, nothing is known of the life history of any Australian species. Smith & Kershaw (1979) and Solem (1988b) suggested that *Arborcinea* (found under bark in dry forests) is based on aestivating juveniles of *Succinea*. Both Patterson (1971) and Solem (1988b) suggest that *Austrosuccinea* is probably not a valid genus. Succineids are not known to be of any economic importance.