Chapter 5

Discussion

Eighteen species of mangrove pulmonates of the upper Gulf of Thailand were recorded in this study. Two species are first record to Thailand i. e. *Laemodonta* sp. and *Platevindex* sp., while *Salinator* sp. is a first record in the Gulf. *Laemodonta* sp. distributes along both coastal Gulf of Thailand and Andaman seashore. Five ellobiid species reported by Brandt in 1974 were not found in this study. They are *Auriculastra subula*, *Cylindrotis quadrasi*, *Laemodonta monilifera*, *L. punctatostriata*, and *Melampus pulchellus*. Habitat destruction and pollution may be the cause of species disappearance and emigration.

It is shown in the present study that shell morphometry of ellobiids can be used to identified at the species level in some genera (Table 4-1). *Ellobium aurisjudae* and *E. aurismidae* were identified by aperture length / body whorl length ratio, aperture length / shell length ratio, and shell length / shell width ratio. *Pythia* spp. were identified by shell width / aperture length ratio. In genus *Laemodonta*, *Laemodonta* sp. is distinctly different from each other by spire length / body whorl length ratio. Shell of *L. punctigera* and *L. siamensis* are very similar except color and apertural teeth. *L. punctigera* has light brown color with dark brown bands on body whorl and a bifurcated parietal tooth. *L. siamensis* has brown color without dark bands and a simple parietal tooth. Certain genera can also be identified by shell morphometry i. e. *Ellobium* and *Pythia*. In genus *Cassidula*, it may not be easily identified to species by shell morphometry but they possess other distinct different morphological characteristics. *Ca. aurisfelis* has strongly indented suture and bifurcated columellar tooth while *Ca. mustelina* has slightly indented suture and a simple columellar tooth.

Radula is a species-specific character for identification of pulmonate in upper gulf of Thailand. In onchidiid, three cusps of central tooth is a unique form. The variated 9-15 cusps of central tooth with long narrow crown marginal teeth are the patterns of the *Salinator* sp. (Amphibolidae), while *Siphonaria laciniosa* (Siphonariidae) possesses the long narrow radular sheath with single lateral tooth. Radula of Thai *Salinator* sp. differs from *Sa. fragilis* and *Sa. solida* of Australia, by their pentacuspid central tooth with a small unicuspid lateral tooth (covered by 2nd lateral tooth) (Thiele, 1963 and Smith and Stanistic,1998). Ellobiids' radula (Melampinae and Ellobiinae) is rather uniform but it varies within Pedipedinae and Pythiinae (Martins, 1996b). *E. aurisjudae* and *E. aurismidae* differ in shape of the central tooth-base and number of cusps of marginal teeth. *Melampus siamensis* has unique multicuspid marginal teeth that similar to others *Melampus* (a small endocone, a large mesocone and a number of small ectocone) (Hubendick, 1978 and Martins, 1996a). *Pythia plicata* differs from *Py trigona* by the size and crown shape of lateral and marginal teeth. The crown of lateral teeth of *Py. colmani* , the Papua New Guinea species, is similar to *Py. trigona*, which is deeply emarginate of central tooth base and pointed crown of lateral teeth.

Morphology of ovotestis are different within the Families. In Families Amphibolidae and Ellobiidae contain unlobed and cone shaped ovotestis, which located at the apex position, except in the two *Ellobium* species, which are flattened and enclosed by hepatopancreas. Family Onchidiidae have a large and lobed ovotestis at the posterior end of the body.

The penial complex among mangrove pulmonate snail species shows great diversity. Family Ellobiidae were classified into 5 subfamilies by reproductive and central nervous system morphology (Morton, 1955, Martins, 1996a and Martins, 1996b). There are 3 subfamilies presented in Thai mangrove. Subfamily Ellobiinae, *Ellobium* spp. has a long muscular penial sheath and a tiny anterior

vas deferens attach along penial sheath. The penis of *E. aurisjudae* is convoluted with cartilage-like substance in the wall which is the most specialized character of *Ellobium* (Morton, 1955). *E. aurismidae*, Indo-Pacific species, is lacking this character as *E. (Auriculodes) dominicense* of Western Atlantic (Martins, 1996a). Subfamily Pythiinae, *Auriculastra*, *Cassidula*, *Cylindrotis*, *Laemodonta* and *Pythia* present a generalized character of penis. *Cassidula* differ from other genera by its anterior vas deferens, which is large, and not attach to penial sheath. *Cy. siamensis* has a unique penial complex with a very long anterior vas deferens (about 2 times of penial sheath) and not attach to penial sheath. It's penis is about 1/3 of penial sheath but about 2/3 in *Cy. quadrasi* (Fukuda, 1994). In this study *Laemodonta* sp. shows distinctly different from *L. punctigera*, *L. siamensis* and *L. cubensis* (Martins, 1996a) by its anterior vas deferens which is large and not adhere to penial sheath. This is very similar to the genus *Cassidula*. Subfamily Melampinae, *M. (Micromelampus) siamensis* is very similar to the Western Atlantic species, *M. (Detracia) bullaoides* and *M.(D.) floridanus*. They possess a short anterior vas deferens and not adhered to penial sheath. *Si. laciniosa* is lacking of penis but spermatophore is present. Penial complex of *Salinator* sp., which is found in this study, is similar to *Amphibola australis* more than other species in genus *Salinator*. In Onchidiidae, the present or absent of penial gland is an important character for onchidiid genera identification. Penial gland is present in genera *Labella*, *Onchidium*, *Peronia*, *Peronina*, *Quoyella* and *Seperoncis*, but absent in genera *Hoffmanola*, *Lessonia*, *Onchidella*, *Onchidina*, *Paraonchidium* and *Platevindex* (Britton, 1984 and Hyman, 1999).

The general pattern of central nervous system of pulmonate snails are composed of 11 ganglia, which tends to be concentrated into a cerebral ring around esophagus (Hubendick, 1978, Boss, 1982 and Smith and Stanisic, 1998). The concentration and fusion of the ganglia are derived characters (Morton, 1955, Bishop, 1978, Haszprunar, 1988 and Martins 1996b). *E. aurisjudae* and *E. aurismidae* have derived character of parietal ganglia that is divided into posterior and anterior

part. In *Pythia*, slightly chiastoneury is considered a primitive condition. *Siphonaria laciniosa* and *Salinator* sp. show more advanced condition by more concentrated nerve ring. The most advanced mangrove pulmonates are onchidiid slugs, *Onchidium* sp. and *Platevindex* sp. which exhibit a close contact of ganglia and fusion of parietal and pleural ganglia. Bishop (1978) proposed 8 patterns of ganglia fusion of visceral chain (cited in Bargmann, 1930) and hypothesized pathways of ganglia fusion of pulmonate snails. The ellobiids and *Salinator* sp. present in this study should be classified as visceral nerve chain type I of Bargman because of its ganglia of visceral chain are separated by long commissure, while *Siphonaria laciniosa* and onchidiids are classified as visceral nerve chain type VII of Bargman by left and right parietal and pleural fusion. Visceral nerve chain type I is the most primitive, while *Salinator* sp. is more advanced than ellobiids by the fusion cerebral and pleural fusion. The fusion pathway of nerve ganglia in onchidiid slugs is probably derived from type II of Bargman (Bishop, 1978).

The phylogenic tree in Fig. 4 - 42 show radiation of ellobiids at most upper branch. Morton (1955) assumed ellobiids appear in 350 M. Y. (Carboniferous period). Thus, *Pythia* were speciated during 350 – 400 M. Y. and other ellobiids were radiated about 265 M. Y. (Permian period). *Melampus* and *Ellobium* were diversed at 176 M. Y. (Jurassic period). Martins (1996b) discussed about the origin of Ellobiinae and Melampinae. The Melampinae arose from the common Pythiinian ancestor but Ellobiinae diversed very early from the ancestral stock that give rise to Pythiinae. Speciation of *Laemodonta*, *Ellobium* and *Pythia* may occurred in Cretaceous period. The position of *Laemodonta* sp. on the family tree are grouped with *Cylindrotis siamensis* by esophageal nerve ring morphology (character 7-9). The length of commissure is not as good as reproductive system for family tree reconstruction. Better understanding of the evolutionary tree will need more characters such as morphology of shell, alimentary tract, embryo, development process and pallial organ including more taxa (other subfamilies) and habitats.

The most primitive ellobiid, *Pythia* contains many primitive character such as sperm groove, penis structure, development of accessory genital gland, radula, nervous system (less concentration and chiastoneury) while its pallial organ is considered an advance character (Morton, 1955 and Martins, 1996b). *Melampus* contains some primitive character, such as pallial organ, but the combination of ganglionic concentration and non-glandular, advanced semidiaulic pallial gonoduct indicated that the Melampinae are the least primitive ellobiids.