although experiencing different weather conditions after the age of 100 days.

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Mycoflora Identified From Failed Green (*Chelonia mydas*) and Loggerhead (*Caretta caretta*) Sea Turtle Eggs at Heron Island, Australia

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Mortality during the early stages of sea turtle embryonic development is relatively high (Richardson and Richardson, 1982). Excavations of emerged nests indicate a significant proportion of eggs fail to hatch (Bustard, 1972; Fowler, 1979; Whitmore and Dutton, 1985) in both natural and artificial nests. This is usually attributed to beach erosion, depredation, plant root invasion, excessive rainfall, tidal inundation, pathogenic infection, and developmental abnormalities. Movement-induced mortality may occur in relocated nests (Limpus et al., 1979; Limpus, 1980; Parmenter, 1980; Blanck and Sawyer, 1981; Whitmore and Dutton, 1985). Some eggs are classified as infertile (Bustard, 1972; Fowler, 1979; Stancyk et al., 1980; Whitmore and Dutton, 1985). However, because unhatched eggs are not identified as such until after the normal incubation time has passed, early embryonic death and subsequent decomposition in the intervening time may be inappropriately interpreted as "infertility" (Parmenter, 1980; Wyneken et al., 1988). Parmenter (1980) suggested use of the term "undeveloped" to include all eggs that show no macroscopic signs of development after a full term interval. Microscopic examination of undecomposed eggs is the only process that may prove lack of embryonic development.

Excavation of emerged nests at various sea turtle rookeries often results in the detection of fungal growth on the shell exterior and in the contents of unhatched eggs. Microbes (including fungi) have been described from the exterior and/or embryonic tissue of eggs of several species of sea turtle including the loggerhead, *Caretta caretta* (Ragotzkie, 1959; McGehee, 1975; Wyneken et al., 1988; Peters et al., 1994); green, *Chelonia mydas* (Bustard and Greenham, 1968; Solomon and Baird, 1980; Whitmore and Dutton, 1985); leatherback, *Dermochelys coriacea* (Whitmore and Dutton, 1985; Solomon and Tippett, 1987; Eckert and Eckert, 1990), and olive ridley, *Lepidochelys olivacea* (Mo et al., 1990). Most observations are of "black" eggs, or those showing discolored contents and embryonic material. In this study, we examined blackened eggs from an Australian sea turtle rookery for presence of mycoflora.

Methods. — During the assessment of hatch success in emerged green and loggerhead sea turtle nests at Heron Is. (23°26'S, 151°55'E), eastern Australia, in the 1996–97 and 1997–98 nesting seasons, eggs from nests that appeared contaminated by fungus (i.e., eggshells blackened with presumed fungal presence) were swabbed and cultured for mycoflora. Swabs (MW170 TRANSTUBE, Amies Clear Transport Media) were refrigerated at 3–5°C prior to analysis. A single egg was cultured from each contaminated nest.

Mycoflora were incubated on half-strength Potato Dextrose Agar with 0.05 g/L chloramphenicol, then subcultured onto other media (e.g., Potato Dextrose Agar, Nutrient Agar, Carnation Leaf Agar) as required for identification according to Seifert (1996). Identification of the species not encompassed by Seifert (1996) was based on previous unpublished work (CJL) and confirmed by the Adelaide Women's and Children's Hospital, South Australia.

Results and Discussion. — Cultures were obtained from 50 nests (39 green and 11 loggerhead). Only three fungal species were detected frequently: *Fusarium oxysporum*, *F. solani*, and *Pseudallescheria boydii*. Multiple samples of these three species were obtained from the nests examined (Table 1). Only 2 nests (both green turtle) demonstrated presence of more than a single fungal species: *F. oxysporum* plus *P. boydii* in one nest, and *F. solani* plus *P. boydii* in the other.

Fusarium oxysporum and *F. solani* are common, cosmopolitan soil saprophytes (Burgess, 1981). *Fusarium solani* has been isolated from failed olive ridley eggs (Acuña-Mesén, 1992) and implicated in the poor health of loggerhead hatchlings emerging from heavily infested soil (Rebell et al., 1971), and *F. oxysporum* has been isolated from the egg membranes of American alligators (*Alligator mississippiensis*) (Schumacher and Cardeilhac, 1990). Mo et al. (1990) isolated an unidentified *Fusarium* from the eggshell of unhatched olive ridley eggs in Costa Rica.

Pseudallescheria boydii is a common soil- and water-inhabiting fungus with a circumglobal distribution. It does not have a high inherent virulence, but is an opportunistic infectant described in the medical and veterinary literature (Rippon, 1982). *Monosporium apiospermum*, the anamorph of *P. boydii*, has been isolated from olive ridley nests in Costa Rica (Acuña-Mesén, 1992).

The contamination of non-viable eggs by mycoflora naturally occurring within the nest substrate is not surprising, but such mycoflora may still have pathological results. Solomon and Tippett (1987) and Wyneken et al. (1988) described the failure of eggs in natural and artificial nests as occurring in clusters. This suggests an infectious etiology. The species- and habitat-specific nest mortality described by Limpus et al. (1983) on the islands of the southern Great Barrier Reef and adjacent mainland suggest fungal presence within sea turtle nests may be contributing to egg failure. Further investigations are underway to determine the extent and impact of mycoflora on embryo mortality in the four species of sea turtle commonly breeding in eastern Australia.

Table 1. Occurrence of mycoflora in green and loggerhead sea turtle nests at Heron Island, Australia.

Fungal Species	Presence (%) in Contaminated Nests: Green (n = 39)	Loggerhead (n = 11)
Fusarium oxysporum	15	0
Fusarium solani	38	73
Pseudallescheria boydii	51	27

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A Tortoise Survey of Shwe Settaw Wildlife Sanctuary, Myanmar, with Notes on the Ecology of *Geochelone platynota* and *Indotestudo elongata*

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The current conservation status of most turtles in Myanmar (formerly known as Burma) is unknown, and old fragmentary observations remain the principal source of information (McCord, 1997; van Dijk, 1997; Platt et al., 2001). The Burmese star tortoise (*Geochelone platynota*) is endemic to the dry zone of central Myanmar, and is considered one of the least known of all living tortoises (Groombridge, 1982; Moll, 1989a). The elongated tortoise (*Indotestudo elongata*) is found in much of Southeast Asia, and probably occurs or formerly occurred in a variety of habitats throughout Myanmar (Moll, 1989b; Iverson, 1992; van Dijk, 1993). Populations of *G. platynota* and *I. elongata* in Myanmar are now believed to be declining due to habitat destruction and over-exploitation, and both species are currently listed on Appendix II of CITES, as are all tortoises excepting those on Appendix I (Groombridge, 1982; Moll, 1989a,b; CITES, 2001). Consequently, status surveys and life history studies have been accorded high priority (Groombridge, 1982; Moll, 1989a,b; van Dijk, 1997). We herein report the results of a recent survey to assess the conservation status of tortoises in the Shwe Settaw Wildlife Sanctuary (SSWS), gather life history data, and provide conservation recommendations based on these findings.

Methods

Study Area. — Shwe Settaw Wildlife Sanctuary (20°11'N, 94°28'E) was established in 1940 for the protection of Eld's deer (*Cervus eldi thamin*) (Salter and Sayer, 1986). SSWS is located on the western edge of the central dry zone within the rain shadow of the Arakan Mountains (FAO/UNDP, 1982). The total area of the sanctuary was originally 553 km^2 (FAO/UNDP, 1982), but this was recently reduced by the sale of 178 km^2 to an agricultural development consortium (Platt, 1999).

Low hills and deep ravines characterize the terrain in SSWS. Elevation ranges from 100 to 550 m above sea level (FAO/UNDP, 1982). Mean annual rainfall is ap-