

INTRODUCTION

The Hawaiian Archipelago, located more than 4000 km from the nearest continent and 3000 km north of the Marquesas, the nearest high islands, is the world's most isolated group of islands (Fig. 1). As a result, the Hawaiian flora and fauna, derived from a relatively small number of colonists, have a high degree of endemism and are rather vulnerable to disturbance. Many groups, notably Hawaiian honeycreepers (Drepanidinae), lobeliads (Lobeliaceae), pomace flies (Drosophilidae), and land snails (Achatinellidae, Amastridae, and others), offer outstanding examples of adaptive radiation.

The stimulating evolutionary insights provided by Hawaiian plants and animals are tempered by the bleak prospects for their continued survival. The ecological consequences of their remarkable adaptation to the isolated Hawaiian environment have been severe. Native plants and animals have been ravaged by anthropogenic activity since Polynesians arrived ca. 400 A.D. (Kirch 1982). Recent fossil finds (Olson and James 1982a, 1982b) indicate that over 40 species of birds became extinct between Polynesian contact and the landing of Captain Cook in 1778, including an entire group of large, flightless geese, at least eight rails, and a constellation of lowland dry habitat passerines. In the 200 years since Western contact, an additional 20 species and subspecies of birds appear to have been extirpated, and 31 taxa have become endangered or threatened (Table 1; U.S. Fish and Wildlife Service 1983). The greatest concentration of endangered birds in the world occurs in the Hawaiian Islands; they represent 7% of the taxa on the International Council for Bird Preservation list (King 1978).

The reasons for these losses are numerous. With the Polynesians came the Polynesian rat (*Rattus exulans*), the pig (*Sus scrofa*), and the dog (*Canis familiaris*). Early Hawaiians probably hunted a large number of flightless birds to extinction and essentially eliminated lowland forests and woodlands by burning and clearing for agriculture (Barrau 1961, Kirch 1982). Subfossil bird bones interred with the charred shells of extinct land snails are the last remnants of these vanished ecosystems (Olson and James 1982b). The extinction rate drastically increased in many taxa following Western contact due to further habitat degradation by man and introduced ungulates (Perkins 1903, Berger 1981), disease (Warner 1968, van Riper et al. 1982), hunting (Munro 1944), competition from introduced birds and insects for food (Banko and Banko 1976, Berger 1981, Mountainspring and Scott 1985), preda-

tion by introduced mammals, particularly the cat (*Felis catus*), black and Norway rats (*Rattus rattus* and *R. norvegicus*), and the mongoose (*Herpestes auropunctatus*) (Perkins 1903, Atkinson 1977), and perhaps gene pool impoverishment due to reduced populations (Zimmerman 1948, Sincock et al. 1984). Inimical factors continue to threaten the endemic biota, and today entire communities are threatened with extinction. An air of urgency thus surrounds studies of the Hawaiian avifauna.

The study of the Hawaiian avifauna has spanned three phases. The first was a descriptive and exploratory phase that began with the Hawaiians who named the species they encountered. This phase intensified with the arrival of Cook in 1778. Eleven taxa of birds were described from specimens collected during Cook's visit to Hawaii and Kauai (Medway 1981). Collection and description of new species continued with the work of Bloxam, Townsend, and Deppe during the early 19th century (Wilson and Evans 1890-1899). Many new species were collected by Pickering and Peale (Peale 1848) during the Wilkes Expedition of 1838-1842. The first reliable listings of the birds of the Hawaiian Islands were by Dole (1869, 1879).

Ornithological interest in the islands increased dramatically in the second phase, beginning with the last two decades of the 19th century, when most taxa were described. The turn-of-the-century era significantly increased our understanding of the Hawaiian avifauna at a time when birds were apparently declining rapidly in numbers. Wilson made extensive collections during 1887-1888 and described the avifauna in his classic tome *Aves Hawaiienses: The Birds of the Sandwich Islands* (Wilson and Evans 1890-1899). Wilson's efforts were followed by the major collecting expeditions of Palmer in 1890-1892 and Perkins in 1892-1894 and 1895-1897. Relying on Palmer's collections, Baron Rothschild (1893-1900) produced three lavishly illustrated volumes entitled *The Avifauna of Laysan and the Neighbouring Islands* that covered the entire Hawaiian archipelago. Important studies and collections by Perkins on the systematics and natural history of the native land birds, insects, and molluscs culminated in the great *Fauna Hawaiiensis* (Sharp 1899-1913, Perkins 1903). During the early part of the 20th century, Henshaw (1902) and W. A. Bryan (1905, 1908; Bryan and Seale 1901) recorded many important observations on the natural history and distribution of Hawaiian forest birds. Following this productive era, a long period of relative dormancy en-

TABLE 1
CONTINUED

Taxa	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	NWHI
Ou							
<i>Psittirostra psittacea</i>	EN	EX	EX	EX	EX	EN	...
Palila							
<i>Loxioides bailleui</i>	EN	...	...	...	...	...	...
Lesser Koa-Finch							
<i>Rhodacanthis flaviceps</i>	EX	...	...	...	...	...	...
Greater Koa-Finch							
<i>Rhodacanthis palmeri</i>	EX	...	...	...	...	...	...
Kona Grosbeak							
<i>Chloridops kona</i>	EX	...	...	...	...	...	...
Maui Parrotbill							
<i>Pseudonestor xanthophrys</i>	...	EN	...	...	...	...	...
Common Amakihi							
<i>Hemignathus virens virens</i>	NE	...	...	...	...	...	...
<i>Hemignathus virens wilsoni</i>	...	NE	NE	EX?	...	...	...
<i>Hemignathus virens chloris</i>	...	...	...	...	NE	...	...
<i>Hemignathus virens stejnegeri</i>	...	...	...	...	...	NE	...
Anianiau							
<i>Hemignathus parvus</i>	...	...	...	...	...	NE	...
Greater Amakihi							
<i>Hemignathus sagittirostris</i>	EX	...	...	...	...	...	...
Hawaiian Akialoa							
<i>Hemignathus obscurus obscurus</i>	EX	...	...	...	...	...	...
<i>Hemignathus obscurus lanaiensis</i>	...	...	...	EX	...	...	...
<i>Hemignathus obscurus ellisianus</i>	...	...	...	...	EX	...	...
Kauai Akialoa							
<i>Hemignathus procerus</i>	...	...	...	...	...	EN	...
Nukupuu							
<i>Hemignathus lucidus affinis</i>	...	EN	...	...	...	...	...
<i>Hemignathus lucidus lucidus</i>	...	...	...	...	EX	...	...
<i>Hemignathus lucidus hanapepe</i>	...	...	...	...	...	EN	...
Akiapolaau							
<i>Hemignathus munroi</i>	EN	...	...	...	...	...	...
Kauai Creeper							
<i>Oreomystis bairdi</i>	...	...	...	...	...	NE	...
Hawaii Creeper							
<i>Oreomystis mana</i>	EN	...	...	...	...	...	...
Maui Creeper							
<i>Paroreomyza montana newtoni</i>	...	NE	...	...	...	...	...
<i>Paroreomyza montana montana</i>	...	...	...	EX	...	...	...
Molokai Creeper							
<i>Paroreomyza flammea</i>	...	...	EN	...	...	...	...
Oahu Creeper							
<i>Paroreomyza maculata</i>	...	...	...	...	EN	...	...
Akepa							
<i>Loxops coccineus coccineus</i>	EN	...	...	...	...	...	...
<i>Loxops coccineus ochraceus</i>	...	EN	...	...	...	...	...
<i>Loxops coccineus rufus</i>	...	...	...	...	EX?	...	...
<i>Loxops coccineus caeruleirostris</i>	...	...	...	...	...	NE	...
Ula-ai-hawane							
<i>Ciridops anna</i>	EX	...	...	...	...	...	...
Iiwi							
<i>Vestiaria coccinea</i>	NE	NE	NE	EX	NE	NE	...
Hawaii Mamo							
<i>Drepanis pacifica</i>	EX	...	...	...	...	...	...
Black Mamo							
<i>Drepanis funerea</i>	...	...	EX	...	...	...	...
Crested Honeycreeper (Akohekohe)							
<i>Palmeria dolei</i>	...	EN	EX	...	...	...	...

TABLE 1
CONTINUED

Taxa	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	NWHI
Apapane							
<i>Himatione sanguinea sanguinea</i>	NE	NE	NE	NE	NE	NE	...
<i>Himatione sanguinea freethii</i>	...	...	...	...	...	...	EX
Poo-uli							
<i>Melamprosops phaeosoma</i>	...	EN	...	...	...	...	...
Totals							
Extinct	11	3	5	6	7	0	3
Endangered or threatened	13	10	7	2	5	12	4
Not endangered	8	5	4	2	5	8	0

* Nomenclature follows the 1983 A.O.U. Check-list and 35th Supplement. NE = nonendangered; TH = threatened; EN = endangered; EX = extinct; ? = present status uncertain; ?? = presently absent, status uncertain at Western contact (1778); ... = believed to be absent at Western contact.

sued until after World War II, relieved only by the noteworthy forest bird surveys of Munro (1944).

The third phase, the modern era, was heralded by the early studies of Baldwin (1944, 1945a, 1945b, 1947a, 1947b) and Schwartz and Schwartz (1949). World interest in the Hawaiian avifauna was greatly stimulated by the systematic studies of Amadon (1950) and ecological studies of Baldwin (1953). Warner (1968) demonstrated the potential role of disease in decimating Hawaiian birds. A. J. Berger and his students at the University of Hawaii began in-depth studies of breeding biology of the Hawaiian avifauna (Berger 1969a, 1969b, 1969c, 1970; Berger et al. 1969; Conant 1977; Eddinger 1969, 1970, 1972; van Riper 1972, 1973b, 1978c, 1980, 1982, 1984). A complete review of the Hawaiian avifauna was written by Berger (1972) and revised in 1981. H. D. Pratt (1979) provided the latest major taxonomic revision of Hawaiian land birds. During the 1970s, the International Biological Program focused research efforts on the mid-elevation east slope of Mauna Loa; these results were reviewed in Mueller-Dombois et al. (1981).

Interest in the Hawaiian avifauna intensified during the 1960s with major efforts by U.S. Fish and Wildlife Service biologists on literature review (Banko 1980-1984, Banko and Banko 1976), the birds of the Northwestern Hawaiian Islands (J. L. Sincock and E. Kridler, unpub. data) and the birds of Kauai (Richardson and Bowles 1964, Sincock et al. 1984). The Smithsonian Institution launched a major investigation of Pacific seabirds that added tremendously to our knowledge of the Northwestern Hawaiian Islands (Kepler 1967, 1969; Clapp and Woodward 1968; Amerson 1971; Clapp 1972; Woodward 1972; Ely and Clapp 1973; Amerson et al. 1974; Fleet 1974; Clapp and Wirtz 1975; Clapp and Kridler 1977; Clapp et al. 1977). From 1976 to 1982, the U.S. Forest Service funded a major

research program by C. J. Ralph to study the behavior of native birds. This study focused on a limited number of sites and obtained a perspective on seasonal and year-to-year variation lacking in our study. A manuscript describing these results is in preparation.

Olson and James (1982a, 1982b) have unearthed dozens of new fossil birds species that prompted a reassessment of the impacts of Polynesians on the Hawaiian avifauna. Laboratory investigations have also contributed to our understanding of the relations of the evolution, ecology, morphology, and physiology of native birds (Richards and Bock 1973; MacMillen 1974, 1981; Raikow 1975, 1976, 1977; Weathers and van Riper 1982).

Despite earlier studies, in 1976 we knew little about the current status of most native Hawaiian forest birds, because vast areas of the islands were still ornithologically unexplored (Berger 1972). As recently as 1973, a new genus of honeycreeper was discovered on the island of Maui (Casey and Jacobi 1974), and even by 1980 the nests, eggs, and young had been described for only 11 of 37 extant passerine taxa (Scott et al. 1980). In 1976, recovery plan drafts for Hawaiian forest birds were largely statements of the need for information on the basic biology of endangered forest birds.

The primary reason for this lack of information on Hawaiian forest birds was the difficulty of working in most forested areas of the State. Hawaiian rainforests have been described as having some of the most inhospitable terrain in the world for conducting field research (Seale 1900). The difficult conditions include rainfall of 10-20 m/year, continual cold drizzle for days or weeks on end, frequent dense fog, steep slopes, sheer cliffs, 10-15 deep gulches per kilometer along contours in many areas, nearly impenetrable vegetation, treacherous earth cracks and lava tubes, and remote areas far from road access.