Numbers of Hawaiian Species: Supplement 1

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This is a supplement to our earlier tabulation of species known from Hawaii (Eldredge & Miller 1995; see also Mlot 1995). The Hawaii Biological Survey is currently working on species checklists and bibliographies for many of these taxa, so this should be viewed as an interim report subject to further change. See Eldredge & Miller (1995) for definitions and scope. We have not included bacteria and viruses, but have now included human parasitic protists and helminths. Allison et al. (1995, table 21.3) summarized the numbers of marine species based on Eldredge & Miller (1995).

From literature and unpublished sources, approximately 22,056 species have been recorded from the Hawaiian Islands and surrounding waters. Of these, 8,850 are endemic to the Hawaiian Islands, and 4,465 are nonindigenous species of protists, fungi, plants and animals. These numbers include significant refinements from the previous compilation by Eldredge & Miller (1995), based on continued literature survey and review by specialists, especially among the parasitic Protozoa and helminths. Many gaps in knowledge of Hawaii’s biota remain and many species of protists, algae, fungi, worms and arthropods remain to be described.

Table 1. Estimates of numbers of species of the Hawaiian biota (based on Eldredge & Miller 1995, as updated by this paper and other papers in this issue of Records of the Hawaii Biological Survey).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Total</th>
<th>Endemic</th>
<th>NIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae and other protists</td>
<td>2228</td>
<td>4</td>
<td>57</td>
</tr>
<tr>
<td>Fungi and lichens</td>
<td>2023</td>
<td>240</td>
<td>7</td>
</tr>
<tr>
<td>Flowering plants</td>
<td>1910</td>
<td>850</td>
<td>877</td>
</tr>
<tr>
<td>Other plants</td>
<td>703</td>
<td>243</td>
<td>50</td>
</tr>
<tr>
<td>Mollusks</td>
<td>1656</td>
<td>956</td>
<td>75+</td>
</tr>
<tr>
<td>Insects</td>
<td>7862</td>
<td>5237</td>
<td>2527</td>
</tr>
<tr>
<td>Other arthropods</td>
<td>1795</td>
<td>335</td>
<td>519</td>
</tr>
<tr>
<td>Other invertebrates</td>
<td>2338</td>
<td>785</td>
<td>250</td>
</tr>
<tr>
<td>Fish</td>
<td>1195</td>
<td>139</td>
<td>73</td>
</tr>
<tr>
<td>Amphibians</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Reptiles</td>
<td>24</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Birds</td>
<td>274</td>
<td>60</td>
<td>46</td>
</tr>
<tr>
<td>Mammals</td>
<td>44</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22056</strong></td>
<td><strong>8850</strong></td>
<td><strong>4465</strong></td>
</tr>
</tbody>
</table>

Endemic species are restricted to Hawaii; nonindigenous (= alien, = exotic, includes introduced) species do not naturally occur in Hawaii; indigenous species occur naturally in Hawaii but are not endemic. See Eldredge & Miller 1995 for additional definitions and qualifications.

2. Executive Secretary, Pacific Science Association, P.O. Box 17801, Honolulu, Hawaii, 96817, USA.
Freshwater and terrestrial Cyanophyta (blue-green algae)

We have not yet reconciled the many old records (e.g., MacCaughey 1918, Tilden 1901, 1910) with current nomenclature. Some recent records include Doty & Watson 1981, MacEntee & Bold 1978, and Zimmerman & Bergman 1990. Patterson et al. (1991 and included references) included many Hawaiian species in a phytochemical screening program. The recorded flora of freshwater and terrestrial forms likely approaches 100 species.

Freshwater and terrestrial algae

We have not yet reconciled the many old records (e.g., MacCaughey 1918, Tilden 1901) with current nomenclature, but our original estimate of over 120 species was too low. Recent authoritative records include over 172 diatoms (Fungladda et al. 1983), 26 desmids (Prescott et al. 1975–1983), and 34 macroalgae in streams (Vis et al. 1994). The total likely exceeds 250 species.

Protozoa

The protists of the Hawaiian islands have never been systematically surveyed, but we have accumulated records of 207 species (excluding Foraminifera) from a variety of sources. Only authoritative identifications have been included. We expect that the ultimate number of species will be vastly greater.

**Free-living marine protozoa**: 39 species (Phillips 1977, Larsen & Patterson 1990), in addition to over 1000 species of Foraminifera (Chave 1987).


**Free-living soil protozoa**: At least 31 ciliates, 9 flagellates, 6 Sarcodina, and 10 Testacea recorded from various habitats on Hawaii Island (Bamforth & Egger 1973, Fössner 1993, 1994).

**Parasitic protozoa of terrestrial vertebrates including humans**: 60 species. Alicata (1969) detailed the species known from humans and domestic animals. Other key references include: Colgrove (1976 — dog), Metcalf (1923 — amphibian), Upton et al. (1994 — reptiles), Wallace & Frenkel (1975 — cat), Van Hoven et al. (1992 — deer), and Van Riper (1991 — birds).


**Parasitic protozoa of marine fishes**: 8 species (Basson et al. 1990, Lom 1970, Moser & Noble 1977a, b).

Fungi

We have not yet tabulated the number of fungi beyond our original estimates, but it is worth paying to the recent work on yeasts associated with flowering plants (Starmer 1981), especially Opuntia cactus (Starmer et al. 1990); the recent reviews of rust fungi (over 74 species — Gardner & Hodges 1989, Gardner 1994); and Agaricales (101 taxa — Desjardins et al. 1992).
Platyhelminthes (zooparasitic)


Acanthocephala

Three species not reported in 1995: Moniliformis moniliformis from rats (Alicata 1969) and cockroach (Schaefer 1970); Corynosoma raaschi from Hawaiian monk seal (Dailey et al. 1988); and Meditornychus orientalis from birds (Schmidt & Kuntz 1977); also unidentified species from freshwater fish (Font & Tate 1994).

Nematoda (zooparasitic)


Tardigrada


Bryozoa

Two Hawaiian freshwater bryozoan species were overlooked in our earlier report (Bailey-Brock & Hayward 1984): one new deepwater, marine species described (Chimoniades & Cook 1994).

Mollusca

Cowie et al. (1995) previously cited as “in press” has been published; the 75 non-indigenous species in the table represents non-marine mollusks only—numbers of non-indigenous marine mollusks have not yet been ascertained (R.H. Cowie, pers. comm.).
Annelida: Hirudinea
Two leeches collected in association with freshwater fishes to be added to species list: *Mysobdella lugubris* and *Cystobranchus* sp. (Font & Tate 1994).

Arthropoda: Crustacea
Recent additions to the crustacean fauna of the Hawaiian Islands include: cyclopoid copepod *Haplostomides hawaiensis* (n.sp.) (Ooishi 1994); harpacticoid copepod *Psammopsis stri* (Kunz 1993); ascothoracid cirriped *Laurea bicornata* (n.sp.) and *Zoanthoea cerebroidea* (n.sp.) (Grygier 1985); mysids *Anisonyx hawaiensis* (n.sp.), *A. extranea* (n.sp.), *A. xenops* (Murano 1995), *Holmesmys costata* (Holmquist 1979), and *Gnathophausia longispina* (Wilson & Boehlert 1993); marine isopods *Neonaesia rugosa* and *Cymodocella hawaiensis* (n.sp.) (Bruce 1994); deep-water caridean shrimp *Opeopele lothi* (n.gen. & n.sp.) (Williams & Dobbs 1995).

Terrestrial and freshwater Arthropoda
The numbers for some groups have changed because of continued refinement of synonymies and distribution status in the database (G.M. Nishida, pers. comm.), as well as recent publications (Gillespie 1994—3 new endemic spiders; Asquith 1994—39 new endemic bugs). Many additional endemic species of arthropods remain to be described (e.g. Howarth 1990). Also, for the original figure for nonindigenous species of the insect order Diptera, there was a typographical error in the table. The number for NIS should read 361 rather than 631 (this did not impact the total numbers).

**Insecta:** 7862 total species, including 5237 endemic and 2527 nonindigenous;
**Araeae:** 200 total species, including 126 endemic and 70 nonindigenous;
**Acar:** 529 total species, including 103 endemic and 365 nonindigenous.

**Symphyla:** Has 5 nonindigenous species (Nishida 1994). It was overlooked in the original list.

Chordata: Reptilia
Our original list omitted 3 indigenous species of sea turtles and 3 nonindigenous species of freshwater turtles (C. Kishinami, pers. comm.).

Acknowledgements
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Literature Cited


Speare, R. 1990. A review of the diseases of the cane toad, Bufo marinus, with comments


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