

HOSTS - a Database of the World's Lepidopteran Hostplants

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1. What HOSTS contains

Records of caterpillar hostplants are scattered through published and manuscript sources worldwide and are difficult to retrieve. Many rearing records are never published and so are not accessible to other entomologists. But collected hostplant records form a valuable scientific resource that can be used eventually to answer broader biological questions about how Lepidoptera and plants interact (eg, Letourneau, Hagen & Robinson, 2001). It provides information of immediate relevance to agriculture, ecology, forestry, conservation and taxonomy.



HOSTS brings together an enormous body of information on what the world's butterfly and moth (Lepidoptera) caterpillars eat. The web-based version presented here offers a synoptic data set drawn from about 180,000 records comprising taxonomically 'cleaned' hostplant data for about 22,000 Lepidoptera species drawn from about 1600 published and manuscript sources. It is not (and cannot be) exhaustive, but it is probably the best and most comprehensive compilation of hostplant data available.

We hope that it will be useful to a wide range of biologists and that it will act as a spur to further recording and analysis of caterpillar-plant interactions.

2. Limitations and errors

Limitations

All Lepidoptera groups are covered and subspecific taxa are differentiated. The original source of the record, original form of the names used (prior to taxonomic 'cleaning' and standardisation of nomenclature) and validation and verification fields are not included. This information is, however, retained in the databases used to generate this site. While we have included species that do not

feed on green plants, the known food substrates of these are not listed exhaustively. Such species comprise detritophages and predators and include, for example, most Tineidae and the stored-products pests.

The published compilations from HOSTS (see 4) include record status and the sources of all records.

Errors

The potential sources of error in any compilation of hostplant records such as this are manifold. At the root lies misidentification of either plant or insect by the original observer or recorder. Further errors may occur in the transcription of records. Confusion may occur between similar or identical plant and insect names (eg, *Aristotelia* - Gelechiidae or Elaeocarpaceae) or a transcriber may confuse similar generic names such as *Asperugo* (Boraginaceae) and *Asperula* (Rubiaceae). Confusion may occur when the context is in a language with which the abstractor or transcriber is unfamiliar. A history involving synonymy or misidentification that is later reversed may result in a perfectly valid host record being switched from one species to another.

There are numerous records of Arctiidae (Lithosiinae) apparently feeding on the foliage of vascular plants. Lithosiinae are now thought only to graze epiphytic algae and the algal moiety of lichens (Rawlins, 1984; Kitching & Rawlins, 1999) and all records referring to vascular plant hosts are probably erroneous, referring only to the feeding site. Records of Lithosiinae from mosses are equally suspect.

Records of adult Lepidoptera feeding on fruit or flowers may be confused with larval foodplant records and re-recorded as such in the literature - numerous occurrences are suspected amongst catocaline Noctuidae, for example.

Rearing caterpillars obtained from eggs from a captured female on a hostplant found acceptable by trial and error may result in the publication of a host record that is erroneous in that the relationship is entirely artificial. Such laboratory rearings are not always clearly cited as such.

Erroneous hostplant records are cumulative - repeated citation gives them a spurious authority and they are extremely difficult to detect and delete. As errors accumulate, there is a danger that the 'noise' of different erroneous records may obliterate a correct insect-plant relationship especially if this is a single observation on an unusual hostplant.

Much of the original abstracting for this work was carried out by volunteers unfamiliar with plant and insect nomenclature and unsure of the meaning of some contexts. Manuscript sources were not always perfectly legible. So there is potential for further errors being added in the abstracting process. Thus we may have unwittingly repeated erroneous records here and we have no doubt generated a few new ones. We would appreciate being informed of the shortcomings. At the same time, users should be aware of the pitfalls inherent in using a compilation such as this.

3. Protocols and nomenclature

To explain the format and reliability of the data presented here, and the abstracting and editing that it has received, a brief description is needed of the database used to generate this site. The parental HOSTS database (see Robinson, 1999) is a 'flat' 23-field database currently running in Paradox™ v.4.5 (Corel). Fields for the caterpillar are 'genus', 'species', 'subspecies' and 'author'; fields for the plant are 'genus', 'species' and 'subspecies' (or variety). Additional fields that may be used in initial abstracting are a brief damage description, the locality, secondary source and date (if the last two are cited). Two further fields are used to record whether the record is considered (by the author of the source, or by others including us) doubtful or not, and whether it is a captive rearing. Many hobby rearings of the popular 'exotic' bombycoid moths fall into this latter category. Fields for source and date are filled globally.



At the end of the abstracting procedure the insect and plant names are copied into 'original name' and 'original host name' fields to permit easy referral back to the source at a later date even if a name is altered drastically following further study.

Validation of Lepidoptera names begins with filling the family and subfamily fields from a relational database derived from Generic Names of Moths of the World (Nye, 1975, and subsequent volumes); this detects mis-spelled generic names. Author-names of species are tested against a standard list and edited as necessary: authors' names are abbreviated if they do not fit within the field limit of 17 characters. The entire (four-field) insect names are then tested against a list of current names (derived from previous operations) and if not validated are checked, altered and brought up to date if necessary using current checklists and databases.

As the taxonomic baseline for the Lepidoptera in this work we have used the card catalogues of the BMNH Lepidoptera Section, generally updated to - at worst - 1982, supplemented by more recent taxonomic revisions. For example, Sphingidae nomenclature follows *Hawkmoths of the World: an annotated and illustrated revisionary checklist* (Kitching & Cadiou, 2000); Saturniidae nomenclature follows a manuscript checklist developed by Ian Kitching, Geometridae nomenclature follows Scoble (1999); for the butterflies (excepting Nymphalidae) we have used the databases prepared by the late Charles A. Bridges. Article 34.2 of the International Code of Zoological Nomenclature (4th edn) demands alteration ('emendation') of the original spelling of species-group names to conform to the gender of the generic name. This makes the efficient manipulation of names in electronic databases difficult and introduces potential for duplication. Gender agreement has been all but abandoned in modern checklists of Lepidoptera (eg, Nielsen et al., 1996; Scoble, 1999; Kitching & Cadiou, 2000). For similar reasons we have not bracketed authors' names where the current combination differs from that of the original description.

The higher classification of the Lepidoptera adopted here is conservative. Current instability at family and subfamily levels in groups such as the Yponomeutoidea and Gelechioidea makes it preferable to 'lump' small family or subfamily groups to aid retrievability. This has been done, notably, in the Cosmopterigidae and Yponomeutidae.

Generic nomenclature and family placement of plant taxa follows Brummitt (1992), and in HOSTS the plant family field is filled using a relational database derived from this source. Generic names of

fungi, lichens and mosses are not attributed to families but only to Fungi, Musci or Lichenes. The family-group names of flowering plants used are the familiar alternatives to the '-aceae' terminations, viz.: Compositae (Asteraceae); Cruciferae (Brassicaceae); Gramineae (Poaceae); Guttiferae (Clusiaceae); Leguminosae (Fabaceae) (separated into Leguminosae (C[aesalpinoideae]), Leguminosae (M[imosoideae]) and Leguminosae (P[apilionoideae])); Labiatae (Lamiaceae); Palmae (Arecaceae) and Umbelliferae (Apiaceae).

Species-group and varietal plant names have been verified, edited and modernized as necessary using the definitive North American checklist by Kartesz (1994), together with a range of on-line resources: the Missouri Botanical Garden's TROPICOS database, Flora Europaea, ILDIS Legume Web, Australian Plant Name Index and the RBGE Dipterocarpaceae database. These were supplemented by published resources such as Mabberley (1993) and recent floras or, failing these, Index Kewensis and its recent on-line incarnation as part of the IPNI. A plant name found only in Index Kewensis is in all probability archaic and such names are indicated where they occur below.

Records that list just a plant genus as host (eg *Rosa*), records that cite one unidentified species (*Rosa* sp.) and records that cite several unspecified species (*Rosa* spp.) are treated as generic only. Records for which only a vernacular name was given that we have been unable to identify further are excluded.

We have attempted to present the data below using insect and plant nomenclature that is uniform and contemporary. However, the higher classification used for the Lepidoptera is intended to be functional rather than confusing or contentious.

4. More detail - publications from HOSTS

Detailed published compilations from HOSTS are available in press. These books give greater detail than the website, together with comprehensive cross-indexes, record status and full bibliographies. They are indispensable tools for naturalists and professional entomologists.

- Robinson, G.S., Ackery, P.R., Kitching, I.J., Beccaloni, G.W. & Hernández, L.M. 2001. *Hostplants of the moth and butterfly caterpillars of the Oriental Region*. 744 pp.
- Robinson, G.S., Ackery, P.R., Kitching, I.J., Beccaloni, G.W. & Hernández, L.M. 2002. *Hostplants of the moth and butterfly caterpillars of America north of Mexico*. 824 pp. [Memoirs of the American Entomological Institute, Volume 69.]
- Beccaloni, G. W., Viloria, A. L., Hall, S. K. & Robinson, G. S. 2008. *Catalogue of the Hostplants of the Neotropical Butterflies/ Catálogo de las Plantas Huésped de las Mariposas Neotropicales*. m3m-Monografías Tercer Milenio, Volume 8. Zaragoza, Spain: Sociedad Entomológica Aragonesa (SEA)/Red Iberoamericana de Biogeografía y Entomología Sistemática (RIBES)/Ciencia y Tecnología para el Desarrollo (CYTED)/Natural History Museum, London, U. K. (NHM)/Instituto Venezolano de Investigaciones Científicas, Venezuela (IVIC). 1-536 pp., 1 fig, 3 tabs.

5. Role of authors

Gaden Robinson was responsible for the overall project design and management of the HOSTS database, and for records of Lepidoptera exclusive of butterflies and bombycoid moths. Phillip Ackery and George Beccaloni were responsible for butterfly data, including data drawn from card catalogues developed by Ackery, whilst Ian Kitching was responsible for hostplant data of bombycoid

moths. Luis M. Hernández was responsible for abstracting in the latter two years of the project and for development of the bibliography for the hardcopy versions of the data.

6. Acknowledgements

We are extremely grateful to the many people who contributed their own rearing records of Lepidoptera or personal accumulations of data for inclusion in the HOSTS database, particularly Mike Bigger (UK), John W. Brown (USA), Chris Conlan (USA), Rob Ferber (USA), Konrad Fiedler (Germany), Jeremy Holloway (UK), Frank Hsu (USA), Jurie Intachat (Malaysia), Alec McClay (Canada), Bill Palmer (Australia), Pierre Plauzoles (USA) and the generous individuals who contributed rearing records through the WorldWideWeb and who are known to us only as an email address.

We are particularly grateful to Julian Donahue and the Los Angeles County Museum of Natural History for allowing us to include data on Microlepidoptera from the card catalogue prepared by the late J.A. Comstock and C. Henne, and for access to manuscript records by Noel McFarland.

Marian Fricano (Santa Clara University) and Aileen Giovanello (Clark University, international internship 1996) made substantial contributions of abstracted data; Fran Love (North Carolina) painstakingly checked scanned texts and reformatted them for import to Paradox.

Much of the immense task of data abstracting and entry from printed and manuscript sources as well as preliminary editing and name-checking was carried out by volunteers. Many of these were school students on work-experience placements during 1993-2000 from, initially, the Coopers' Company and Coborn School, Upminster, and later from other schools in Greater London: Christopher Andrewes, Simon Bennett (1994 NHM vacation studentship), Steven Bond, Michael Brownlow, Emma Causer, Laurence Cooper, Ailsa Cranfield (1998 Nuffield Studentship), Emily Dwiar, Andrew Enever, Jane Feehan, Madeleine Ferry, Max Friedman, Edward Gold, Jennifer Hodgkinson, Christopher Joint, Fateha Khatun (1996 Nuffield Studentship), James Lowe, Louisa Marchant, Gemma Millward, Christopher Milne, Carolyn Oughton, William Perkins, Rebecca Reith, Eleanor Resheph, Clare Sambidge, Neil Shaftain, Stephen Sloan, Helen Stevens, Samuel Tarry, David Taylor and Thomas Yeatman.

We are indebted to all our helpers for their diligence, accuracy and patience, and for their unswerving faith that this daunting project would reach a conclusion.

Our colleagues here and overseas provided substantial help, advice and assistance with the checking of names of Lepidoptera and with many other aspects of this project: Kim and David Goodger and Jeremy Holloway (Macrolepidoptera families), Martin Honey (Noctuoidea), Brian Pitkin (computing), Malcolm Scoble and Linda Pitkin (Geometroidea), Klaus Sattler (Gelechioidea), Michael Shaffer (Pyraloidea, Thyridoidea, Pterophoroidea), Alma Solis (USDA, Washington - Pyraloidea), Fernley Symons (Oxford University - technical support) and Kevin Tuck (Tortricoidea). Julie Harvey and the staff of the BMNH Entomology and general libraries provided sterling support in locating obscure source material and intuitively correcting bowdlerized references.

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8. INTERNET RESOURCES:

- Caterpillars: especially Australian ones: <http://lepidoptera.butterflyhouse.com.au/>
- Electronic Resources on Lepidoptera: <http://www.chebucto.ns.ca/Environment/NHR/lepidoptera.html>
- Flora Europaea: <http://rbg-web2.rbge.org.uk/FE/fe.html>
- Global Tineidae database: <http://www.nhm.ac.uk/entomology/tineidae/index.html>
- International Plant Names Index (incorporating Index Kewensis, The Gray Card Index and the Australian Plant Name Index): <http://www.ipni.org/index.html>
- LegumeWeb - the ILDIS World Database of Legumes: <http://www.ildis.org/LegumeWeb/>

- Life hierarchy - Markku Savela's Lepidoptera database (includes hostplant data): <http://www.funet.fi/pub/sci/bio/life/insecta/lepidoptera/index.html>
- Missouri Botanical Garden's VAST (VAScular Tropicos) nomenclatural database: <http://mobot.mobot.org/W3T/Search/vast.html>
- Butterflies and Moths of North America: <http://www.butterfliesandmoths.org>
- Royal Botanic Garden Edinburgh Dipterocarpaceae database: <http://193.62.154.38/diptero/>
- Web Images of North American Moth Species: <http://facweb.furman.edu/~snyderjohn/leplist/>