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Glossary of Expressions in Biological Control[1]

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Introduction

Most of the expressions below are straightforward. However, some are controversial in that some writers do not use the term in the preferred sense given below or do not use it at all. The controversial terms and a few others are marked by a number, and are explained more fully with numbered references at the foot of the text.

Most of the definitions below apply to species. When the word species is used, it means species in the zoological or botanical sense. However, in a few of the entries (such as that for the word native) it could also be applied to infraspecific categories (some of which are labeled "species" in the lists of endangered species resulting from the United States Endangered Species Act). Thus, no species of bird or butterfly occurs only in Florida although infraspecific categories ("subspecies") of birds and butterflies and mammals that are recognized only from Florida are named "endangered species" in federal and/or state lists.

Why have a glossary at all? The short answer is "for accuracy." A real example is: the author of a manuscript under review wrote about "superparasitism" of caterpillars of a pest moth -- but the text revealed that he was writing about the caterpillars being attacked by two or three species of hymenopterous parasitoids. What he meant was what earlier authors called multiple parasitoidism (multiple parasitism), so his words would have confused his readers. If his words had been adopted by later uninformed writers, the literature could have become confused for decades. If he had used a glossary like this one, he would have found the correct term.

Terms

Adelphoparasitism: [but see preferred term because these organisms are parasitoids rather than parasites] (noun); a special case of hyperparasitism [but see preferred term hyperparasitoidism] occurring in the chalcidoid family Aphelinidae, in which males not only develop from unfertilized eggs (as is usual in Hymenoptera) but are parasitoids of females of their own species, the females being primary parasitoids of Homoptera. Also, noun Adelphoparasite.[1]

Adelphoparasitoidism: A special case of occurring in the chalcidoid family Aphelinidae, in which males not only develop from unfertilized eggs (as is usual in Hymenoptera) but are parasitoids of females of their own species, the females being

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primary parasitoids of Homoptera. Also, noun adelphoparasitoid.[1]

Adventive or fortuitous biological control: Regulation of a pest population bya natural enemy that has arrived from elsewhere without deliberate introduction. A term used in the literature although it is not really a form of biological control - to qualify, there would ned to be human intervention.

Alien: Native somewhere else (noun and adjective). Same as exotic and foreign (see explanation under exotic).

Arrhenotoky: A common form of sex-determination in Hymenoptera and some other invertebrates, in which progeny are produced by mated or unmated females, but fertilized eggs produce diploid female offspring whereas unfertilized eggs produce haploid male offspring by parthenogenesis (only the females are biparental). See also haplodiploidy. In some Chalcidoidea, arrhenotoky may alternate in successive generations with thelytoky.[3]

Augmentative biological control: Release of large numbers of a biological control agent to supplement the small numbers already present, in expectation of a greatly increased effect. [Contrast with inundative biological control].

Autochthonous: Native; indigenous (adjective); this arcane word means the same as native and indigenous, and those are older and well-accepted expressions.

Biocontrol: The same as biological control. A few people object to the expression biocontrol (noun) as being jargon.

Biological control: The use of living natural enemies to control pests or: The active manipulation of antagonistic organisms to reduce pest population densities, either animal or plant, to noneconomically important levels.[4]

Biopesticide: A living organism applied as an inundative biological control agent or augmentative biological control agent.

Biorational pesticide: A chemical such as a toxin or growth regulator derived from a living organism and applied either as the entire dead organism or as an extract from the organism; alternatively, the chemical or an analog of it synthesized in vitro. Use of biorational pesticides is usually considered to be chemical control not biological control.

Carnivore: An organism that feeds on animals (noun); same as zoophage; also noun carnivory and adjective carnivorous.

Classical biological control: A form of inoculative biological control in which specialist natural enemies are imported from the supposed homeland of an adventive pest, and released in small numbers in attempt to establish a permanent population. A variant form of classical biological control uses biological control agents imported from a third area, inhabited by a close relative of the target pest. Contrast with neoclassical biological control.

Cleptobiont (or Kleptobiont): An organism that obtains its food by robbing another organism of the food that it has collected.

Cleptobiosis (or Kleptobiosis): Robbery of food, in which one insect or other organism takes the food that another has collected, for example in ants in which workers of *Myrmecocystus* intercept workers of *Pogonomyrmex* and take the food that the latter have gathered.

Cleptoparasite (or Kleptoparasite): An organism that exists by cleptoparasitism.

Cleptoparasitism (or Kleptoparasitism): [but see preferred term cleptoparasitoidism]: A form of multiple parasitism in which a parasite preferentially attacks a host that is already parasitized by another species.

Cleptoparasitoid (or Kleptoparasitoid): An organism that exists by cleptoparasitoidism.

Cleptoparasitoidism (or Kleptoparasitoidism): A form of multiple parasitoidism in which a parasitoid preferentially attacks a host that is already parasitoidized by another species.

Commensalism: A situation in which two or more organisms of distant phylogeny use the same food resource without competition (noun); also adjective and noun commensal (from Latin, meaning feeding at the same table).

Competitor: An organism that competes with others for resources (noun).

Conservation biological control: Conservation of biological control agents, which is a part of manipulative biological control

Detritivore: An organism that feeds on detritus (decaying material) (noun).

Deuterotoky: A form of sex-determination (especially in Hymenoptera), in which all progeny are uniparental; females are diploid and produce diploid female offspring and, rarely, haploid males that are biologically nonfunctional (i.e., do not contribute their genetic material to future generations). Deuterotoky is a form of parthenogenesis. See also haplodiploidy.[3]

Direct pest: Said of a pest that damages the marketable part of a plant (e.g., the fruit); contrast with indirect pest.

Ectoparasite: A parasite that lives on the external surface of its host; examples include lice and fleas (noun); also adjective ectoparasitic and noun ectoparasitism.[1]

Ectoparasitoid: A parasitoid that lives on the external surface of its host, feeding on it and killing it in the process (noun); also adjective ectoparasitoidal and noun ectoparasitoidism.[1]

Ectophage: An organism that feeds on (on the outside of) another organism (noun); the corresponding adjective is ectophagous.

Encapsulation: A cellular defense strategy used by hosts of an endoparasitoid (or any other invading organism) to isolate it and deprive it of resources (oxygen and/or nutrients), so as to kill it.

Endemic: Occurring constantly in an area in small numbers, but allowing a switch to large numbers, at which time the population or species is said to be epidemic (adjective); the antonym of epidemic. This is the original meaning of the word, dating from the year 1603, and it has been used constantly in this sense by epidemiologists and ecologists since then. Example: yellow fever is endemic (occurring constantly at low population levels but with sporadic epidemics) in South America although it is believed to be native to Africa.[5]

> Endemic**:** A misinterpretation by zoogeographers to mean "native to an area and occurring nowhere else." This misinterpretation, although it dates only from 1872, so permeates the literature that it will be hard to eradicate although precinctive was suggested in 1900 as an appropriate alternative. Precinctive is the term preferred here.[5]
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> Endemic: A 20th century misinterpretation of the 19th century misinterpretation of the 17th century word endemic, as meaning native.[5]
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> Endemic: A late 20th century use in which species that occur constantly at low population levels are said to be endemic.[5]

Endemism: The condition of being native to and restricted to a specified area. Because the word is based on a misinterpretation of the word endemic, precinction is the term preferred here.

Endoparasite: A parasite that lives in another organism, feeding on it but not usually killing it (noun); also adjective endoparasitic and noun endoparasitism.[1]

Endoparasitoid: A parasitoid that lives in another organism, feeding on it and killing it in the process (noun); also adjective endoparasitoidal and noun endoparasitoidism.[1]

Endophage: An organism that feeds inside another animal (noun); the corresponding adjective is endophagous.

Entomogenous: Reproducing within insects (adjective); used mainly to describe habits of some nematodes.

Entomophage: An organism that feeds on insects (noun); the corresponding adjective is entomophagous.

Entomopathogenic: Producing disease in insects (adjective).

Epidemic: Occurring in unusually large numbers; said of a population or species (adjective and noun). As an adjective, the antonym of endemic.[5]

Exotic: Native somewhere else (adjective). Kangaroos are exotic species as far as inhabitants of North America are concerned, but they are not exotic in Australia. Same as alien and foreign. If you want to say that some species present here has come here from somewhere else, then the word adventive is appropriate because it means exactly that.[2]

Factitious host: A host other than the target host for parasitoids, one that biocontrol practitioners may more readily rear than the target host in a laboratory, thus implying that the biocontrol agent is not absolutely monophagous.

Facultative parasitism [see also expression facultative parasitoidism]: A condition in which a free-living organism may exist by parasitism (parasitoidism) but does not rely upon this way of life.

Facultative parasitoidism: The condition of existing by parasitoidism, but not relying upon this way of life.

Fecundity: The number of eggs that a female of a species can produce during her lifetime; contrast with fertility.

Fertility: The number of viable offspring that a female of a species can produce during her lifetime; contrast with fecundity.

Foreign: Native somewhere else (adjective). Same as alien and exotic (see explanation under exotic).

Fortuitous or adventive biological control: Regulation of a pest population bya natural enemy that has arrived from elsewhere without deliberate introduction. A term used in the literature although it is not really a form of biological control - to qualify, there would ned to be human intervention.

Gregarious parasitoid: A parasitoid whose nutritional requirements are such that several can exist in the body of the host.

Haplodiploidy: A form of sex-determination in which offspring of one sex are haploid and of the other sex are diploid.[3]

Herbivore: See also phytophage (which means the same). An organism that feeds on plants.

Host: The living organism that serves as food for a parasite, parasitoid, or pathogen (noun).

Host-discrimination: The selection of an appropriate host by a parasite or parasitoid, according to the species, developmental stage, and physiological condition (including absence of existing parasites/ parasitoids) of that host.

Host-specific: A parasite, parasitoid, or pathogen that, at least in the area specified, is monophagous.[6]

Host-specificity: The level of specificity of a parasite, parasitoid,or pathogen to its host. The levels are classified as monophagous, stenophagous, oligophagous, and polyphagous.

Hyperparasite: A parasite that lives on another parasite.

Hyperparasitism: [but see preferred term hyperparasitoidism for those that are parasitoids]; parasitism of a parasite. A second-arriving parasite attacks the first, and is a hyperparasite of the host.

Hyperparasitoid: A parasitoid that uses another parasitoid as a host.

Hyperparasitoidism: Parasitoidism of a parasitoid. A second-arriving parasitoid parasitoidizes the first, and is thus a hyperparasitoid of the host. This provides a concept of primary parasitoid (the first-arriving parasitoid), secondary (= second order), tertiary (= third order), etc. parasitoids. Obligate hyperparasitoidism is almost restricted to secondary parasitoidism, but parasitoidism of the 5th order has been recorded.

Idiobiont: A parasitoid whose host is rendered immobile by the parent of the idiobiont, and the said host is consumed in the location and stage it is in

when attacked, or at least in a nearby location to which the parent of the idiobiont has moved it. Contrast with koinobiont.[7]

Immigrant: Native somewhere else, but having arrived in the area specified of its own accord, by walking flying, swimming, rafting, or hitchhiking (adjective). European people are immigrants to Florida (USA); so are cattle egrets and love bugs because they flew to Florida; so are citrus leafminers, which also arrived without deliberate introduction (even if by hitchhiking in a cargo of plants on a plane).[8]

Inadvertently introduced: Avoid using this expression -- use immigrant instead. See immigrant and introduced.

Indigenous: Native (adjective).[9]

Indirect pest: Said of a pest that damages the unmarketed part of a plant (e.g., the leaves, when it is the fruit that is marketed); contrast with direct pest.

> Indirect pest: A legal term used in the United States Code of Federal Regulations. Whatever it meant to the lawyer(s) who wrote it, it was for years interpreted by lawyers to mean an organism higher in a food chain than a pest, which during those years required USDA-APHIS-PPQ to regulate the importation and interstate movement of biocontrol agents of phytophagous arthropods. Legal review in the late 1990s reversed the previous interpretation.

Inoculative biological control: Importation and release of biological control agents in an area in which they are not already present, with intent to establish a permanent population. See also seasonal inoculative biological control.

Insectivore: An organism that feeds on insects (noun); same as entomophage; also adjective insectivorous and noun insectivory.

Insect pest: An unclear term, best avoided. If you wish to indicate that an insect is a pest, it is better to write "pest insect" to make the meaning clear. The term "insect pest" is especially confusing when compared with "plant pest" -- logic suggests that one of those terms includes insects that are pests, but which one?[14]

Introduced: Native somewhere else, but having been brought deliberately by people to the area specified (adjective). Apples, wheat, and domestic cats were introduced to North America.[10]

> Introduced: Native somewhere else, but having been brought deliberately or accidentally by people to the area specified.[10]

> Introduced: Native somewhere else, but having arrived somehow in the area specified. Although this concept makes no logical sense because it clearly includes organisms that arrived entirely without the aid of people, it still is used by some biologists.[10]

Inundative biological control: Release of large numbers of a biological control agent relative to the numbers of a target species, in expectation of a rapid effect. There is no implication that the released biological control agent will establish a permanent population.

Invasive: A population or species that is expanding its range (adjective); often an adventive species, but by definition not necessarily so. Unfortunately, this word has recently been used in places where the word adventive is the appropriate expression - and thus is replacing "non-indigenous" as current jargon.

Kleptobiont (or Cleptobiont): An organism that obtains its food by robbing another organism of the food that it has collected.

Kleptobiosis (or Cleptobiosis): Robbery of food, in which one insect or other organism takes the food that another has collected, for example in ants in which workers of *Myrmecocystus* intercept workers of *Pogonomyrmex* and take the food that the latter have gathered.

Kleptoparasite (or Cleptoparasite): An organism that exists by kleptoparasitism.

Kleptoparasitism (or Cleptoparasitism): [but see preferred term kleptoparasitoidism]: A form of multiple parasitism in which a parasite preferentially

attacks a host that is already parasitized by another species.

Kleptoparasitoid (or Cleptoparasitoid): An organism that exists by kleptoparasitoidism.

Kleptoparasitoidism (or Cleptoparasitoidism): A form of multiple parasitoidism in which a parasitoid preferentially attacks a host that is already parasitoidized by another species.

Koinobiont: A parasitoid developing in a host that continues to be mobile and able to defend itself; hosts that are larvae often are not killed until they have prepared cryptic pupation retreats. Contrast with idiobiont.[7]

Manipulative biological control: The manipulation of elements in the environment to enhance the numbers and/or actions of natural enemies.

Monophagous: Feeding upon a single kind of food (adjective); also nouns monophage and monophagy.

Multiple parasitism: [but see preferred term multiple parasitoidism when the attackers are parasitoids]; a condition in which a host is infested by parasites of more than one species at the same time.

Multiple parasitoidism: A condition in which a host is infested by parasitoids of more than one species at the same time.

Native: Indigenous (adjective). The complement of adventive. Definitions of the word native are somewhat fuzzy, but seem to imply presence of the species in the area in question for a very long time and/or numerous generations, with some level of in situ evolution, even if its very distant ancestors came from somewhere else, i.e., were naturalized (see discussion under natuarlization.[11]). A species may be native to more than one area, such as several states of the USA, or several countries, such as USA (southern Florida) and Cuba and Jamaica.[2, 9]

Natural biological control: Use instead the expression natural regulation.[4]

Natural control: Use instead the expression natural regulation.[4]

Natural enemy: A collective term for parasites, parasitoids, pathogens, predators, and competitors that inflict mortality on a population of a species.

Natural regulation: Regulation of plant or animal populations by any factor except intervention by mankind. Although in various texts this is called "natural control" or "natural biological control", such expressions are not accepted here -- in the definitions that are used here, "control" is something done only by people, so that "biological control", "physical control", and "chemical control" are actions taken by people.

Naturalization: A concept by which, after some time or generations, immigrants or their descendants are considered to be native.[11]

Necrophagous: Feeding upon dead animals (adjective); also nouns necrophage and necrophagy.

Neoclassical biological control: A form of inoculative biological control in which natural enemies are imported from elsewhere and released in small numbers in attempt to establish a permanent population to control a native pest with which they have not co-evolved.[12]

Non-indigenous: A cumbersome expression popular in the early 1990s; prefer to use the expression adventive [= having arrived from elsewhere].[2]

Obligate parasitism: [but see preferred term obligate parasitoidism when speaking or writing about parasitoids]; capable of existence only by parasitism.

Obligate parasitoidism: Capable of existence only by parasitoidism.

Oligophagous: Feeding on few kinds of food (adjective); also nouns oligophage and oligophagy.

Parasite: An organism that lives in or on the body of its host without killing the host, but usually debilitating it (noun).[1]

Parasitic: Acting as a parasite (adjective); but see also the expression parasitoidal.

Parasitism: The condition of living in or on another organism (the host) to obtain food, without killing that host but usually debilitating it (noun); but see also the term parasitoidism.

Parasitize: To act as a parasite (verb); but see also the expression parasitoidize.

Parasitization: Use instead the shorter term parasitism [the word parasitization is cumbersome jargon, so avoid it].[13]

Parasitoid: An organism that, during its development, lives in or on the body of a single host individual, eventually killing that host (noun).[1]

Parasitoidal: Acting as a parasitoid (adjective).[1]

Parasitoidism: Same as parasitism, but for a parasitoid (noun).[1]

Parasitoidize: To act as a parasitoid (verb).[1]

Parthenogenesis: The production of offspring from unfertilized eggs. Special examples of it are arrhenotoky, pseudo-arrhenotoky, deuterotoky, and thelytoky.

Pathogen: A disease-causing organism or entity such as a bacterium, fungus, protozoan, or virus (noun).

Pathogenic: Productive of disease (adjective).

Pest: An animal or plant that is deemed by mankind to be too numerous [this includes weeds].

Phoresy: The habit of gaining transport from one place to another on an animal (i.e., "hitching a ride"; noun; adjective phoretic).

Phytophage: An organism that feeds on plants (noun).

Phytophagous: Feeding upon plants (adjective).

Phytophagy: The habit of feeding upon plants or vegetable matter (noun); herbivory; also phytophage (noun) and phytophagous (adjective].

Plant pest: A legal term used in the United States Code (especially Plant Pest Act) and in the Code of Federal Regulations. Written by lawyers, it is unclear whether this term in some places means plants that are pests (i.e., weeds), or pests of plants (i.e., phytophagous organisms). [Compare with insect pest]

Polyembrony: The production of more than one embryo from an egg, as in some members of the hymenopterous families Braconidae, Dryinidae, Encyrtidae, and Platygasteridae.

Polyphagous: Feeding upon many kinds of food (adjective); also nouns polyphage and polyphagy.

Precinction: This is the term that most zoogeographers, unfortunately, call endemism. It is the condition of being native to and restricted to the area **specified.**[5]

Precinctive: Native to the area specified, and occurring nowhere else (adjective).[5]

Predaceous: Incorrect spelling; see predacious and predatory.[15]

Predacious: Same as predatory.[15]

Predate: This word has nothing to do with predation -- it means antedate.

Predation: The state or condition of being predatory (noun).

Predator: An organism that, during its development, consumes more than one prey individual (noun).

Predatory: Living by preying on others (adjective) [synonym = predacious. The spelling predaceous is incorrect].[15]

Prey: The living organism that serves as food for a predator (noun), also, to act as a predator (verb) as in "prey on."

Prey-specific: A predator that, at least in the area specified, is monophagous.[6]

Prey-specificity: The level of specificity of a predator to its prey. The levels are classified as monophagous, stenophagous, oligophagous, and polyphagous.

Primary parasitoid: A parasitoid of a (specified) host. See also secondary parasitoid.

Protelean parasitism [parasitoidism]: Parasitism [parasitoidism] by juvenile stages of parasites [parasitoids] as contrasted with parasitism [parasitoidism] by adult stages. Not often used, but see Askew (1971).

Pseudo-arrhenotoky: A form of sex-determination (especially in some scale insects and mites) in which males and females arise from fertilized eggs and are diploid. However, males become haploid by inactivation of the paternal genome. See arrhenotoky.[3]

Saprophagous: Feeding upon decomposing matter (adjective); also nouns saprophage (= saprovore) and saprophagy (= saprovory).

Seasonal inoculative biological control: Release of biological control agents in an area in which they cannot survive permanently due to severe climate or other constraints; the expectation is that they will establish a population that will persist for some fraction of a year.

Secondary parasitoid: A parasitoid of a parasitoid of a host. See also primary parasitoid. See also hyperparasitoid.

Solitary parasitoid: A parasitoid whose nutritional requirements are such that only one can exist in the body of the host.

Specific natural enemy (or specific biological agent): A biological control agent that is monophagous; or a biological control agent that is monophagous in the area into which it has been introduced because no other suitable host/prey occurs in that area.

Stenophagous: Feeding upon a narrow range of foods (adjective); also nouns stenophage and stenophagy.

Superparasitism: [but see preferred term superparasitoidism when speaking or writing about parasitoids]: The situation in which more individuals of a parasite species develop in a host than can obtain adequate resources to complete their development.

Superparasitoidism: The situation in which more individuals of a parasitoid species develop in a host than can obtain adequate resources to complete their development. Females of some parasitoids may lay more than one egg in or on a host, resulting in superparasitoidism, although the behavior of females tends to avoid this condition by discriminating against already-parasitoidized hosts. In fact, five conditions can be distinguished (a) only one parasitoid exists within the host; (b) there is more than one parasitoid within the host, but all survive and produce adults of normal size [this is not superparasitoidism]; (c) there is more than one parasitoid within the host and they all survive but produce adults of subnormal size because of competition for resources [this is viewed here as superparasitoidism]; (d) there is more than one parasitoid within the host and some of them die due to competition for resources (including attack by conspecifics) [this is superparasitoidism]; and (e) there is more than one parasitoid within the host and all die because the resources are too few [this is superparasitoidism].

Thelytoky: A form of sex-determination (especially in Hymenoptera: Symphyta and Cynipidae) in which only diploid female progeny are produced -- there are no males. Deuterotoky may be seen as a variant of thelytoky. See also haplodiploidy and parthenogenesis.[1]

Vector: An animal that transmits a pathogen to plants or animals (noun).

Zoophagous: Feeding upon animals (adjective).

Footnotes

Further Explanation of Little-used or Troublesome Words:

1. The word **parasitoid** was coined by Reuter (1913) to distinguish this ecological group of organisms from predators and parasites. Although it has been widely adopted into English for many decades, some writers still do not use it and lump parasitoids together with parasites. But, parasitoids typically kill the host (whereas parasites do not) so in this way are more akin to predators than to parasites. If we accept the word **parasitoid**, then it becomes logically difficult to accept that they **parasitize** a host

(because that clearly is an action by parasites), nor that the appropriate noun is **parasitism**. If we accept the word **parasitoid**, then the appropriate verb and noun are respectively **parasitoidize** and **parasitoidism** (see Frank and McCoy 1989). Also, the expressions **adelphoparasitoid**, **ectoparasitoid**, **endoparasitoid**, **hyperparasitoid**, **superparasitoid**, and **multiple parasitoidism** are appropriate.

2. **Adventive:** arrived in the area specified from somewhere else by any means (adjective); not native (non-indigenous) to the area in which it has been found. Various authors have used expressions **alien** and **exotic** in this sense, but these are inadequate because they do not imply that the organism in question has arrived in an area previously unoccupied by it. Other authors erroneously use the word **introduced**, but that word implies an action by people. The word **adventive** was first used by Bacon (1605), and more recently by Pemberton (1964). It is the exact complement of the word **native**. There is nothing controversial about this word, but many writers are simply unaware of it.

3. **Arrhenotoky, pseudo-arrhenotoky, deuterotoky, thelytoky:** females are diploid, but males (where they occur, in arrhenotoky, pseudo-arrhenotoky, and deuterotoky) are haploid (see **haplodiploidy** and **pathenogenesis**). These expressions are not controversial, but are not as widely used as they might be.

4. If we accept the definitions of biological control above (that biological control is an action by people, equivalent to chemical control and physical control), then logically there can be no such things as **natural biological control** and **natural control**. Instead, we are forced to use an expression such as **natural regulation** to explain the actions of biotic and non-biotic factors in regulating populations. **Natural regulation** is, anyway, the expression used in the science of ecology for this phenomenon. For further discussion, see Franz (1960).

5. There are two main uses of the word **endemic**. The first use (meaning occurring constantly but generally at low population levels), 400 years old (Lodge 1603), is still correct. It is used by ecologists, epidemiologists, and the popular press. The second use (by zoogeographers, to mean native to an area and occurring nowhere else) is a misinterpretation of the original meaning made about 250 years later, by no less an author than Charles Darwin (1872). Darwin's misinterpretation was exposed and corrected 28 years later by David Sharp (1900). Sharp was too late and published in too obscure a work: the great mass of writers paid no attention, and a stampede is hard to stop. So we are now faced with two meanings of the word, one correct, and one (the zoogeographical meaning, Darwin's meaning) incorrect but with the valid alternative **precinctive**. Darwin's further use of the word in other places and without definition, led to yet another misinterpretation, and this third meaning (as a synonym of **native**) is echoed by Ehrlich and Roughgarden (1987) and in various Merriam-Webster's dictionaries. Finally, there is a fourth meaning (Wallner 1987), which deems species that occur continuously at low population levels to be endemic, but which seems not to have been adopted by subsequent writers. These definitions are explored in greater detail by Frank and McCoy (1990).

Here, we recognize two major origins of organisms in an area: those that are **native** and those that are **adventive** (came from somewhere else, regardless of method of arrival). Among the **native** organisms are those that are **precinctive** (exist nowhere else), and those that have a more widespread distribution. Among the **adventive** species are those that were **introduced** deliberately by people (this restriction in word usage follows Zimmerman 1948) and those that arrived by any other means, called here **immigrant** (see Frank and McCoy 1990, 1995, following textbooks on ecology and Sailer 1978).

A. **Native** (= indigenous)

- Precinctive (native and occurring only here)
- Native but not precinctive (native and occurring elsewhere, too)

B. **Adventive** (= "non-indigenous", arrived from somewhere else)

- Immigrant (arrived uninvited).

- Introduced (introduced deliberately by people).[10]

Why is the distinction between immigrant and introduced important? Because Zimmerman (1948) blamed the demise or declining populations of 27 species of native Lepidoptera in Hawaii on introduced biological control agents. Later examination showed that only one of the blamed "biological control agents" had been introduced, in 1895 -- the others were immigrants, which had not been imported deliberately to Hawaii. Even labeling these others "accidentally introduced", when nobody knows their real means of arrival (they might have arrived on high-altitude winds), still allows the charge that "introduced" species caused problems for the native Lepidoptera; it is preferable to label all that arrived without documentation as immigrants, and thus to reserve the term "introduced" for those that were deliberately introduced.

6. **Host-specific**, and **prey-specific** are expressions that imply monophagy on a single host or prey species (not genus or family). This may be absolute monophagy. Alternatively, it may be "ecological monophagy" in that the organism is stenophagous, but only one suitable host or prey occurs in the area into which the organism is introduced. "Suitable host or prey" means one on which the organism feeds and can complete its development. Functionally, the same situation may be reached by introduction of a biological control agent to control more than one target species belonging to a single genus, in an area where no other suitable hosts or prey occur, but in this situation the organism is not monophagous and it is arguable whether it may be called host-specific or prey-specific ("specialized" is perhaps a more apt term).

7. The terms **idiobiont** and **koinobiont** were advocated by Haeselbarth (1979) in German. They have been used in English. They are not controversial, but are not as widely used as they might be.

8. The expression **immigrant** was established first in the 18th century and applied only to humans. It was used in the 20th century in all or almost all ecology textbooks for all organisms, and then (Sailer 1978) specifically for insects. It must be obvious to biologists that (for example) Hawaii's native fauna was established by immigration (an entirely natural process) of animals from elsewhere because the Hawaiian Islands arose by volcanic action from the sea floor. This expression is here extended to all other situations in which organisms arrived in a previously-unoccupied area without deliberate help from people. For example, the (*Plecia nearctica*) and cattle egret (*Bubulcus ibis*) arrived in Florida by flight from other areas; they are **immigrants**, and were not "introduced" (nobody introduced them).

9. The expression **indigenous** is a valid alternative to **native**. The complement of **indigenous** (in the sense of being present but not being **indigenous**) is **non-indigenous** (a cumbersome expression). The equivalent complement of **native** is **adventive**. The expressions **alien** and **exotic** do not give the sense of being present here. The expressions **indigenous** and **native** imply that the clade (species, subspecies, etc.) evolved here or jointly here and in neighboring areas, or at least that some level of differentiation from non-native progenitors occurred here. This may perhaps be the same rule that is applied by United States law to declare Amerindians (an infrasubspecific category) to be native Americans. See the concept of **naturalization**, which must at some level be applied to plants and animals..

10. The term **introduced** has been used in three senses. Here, for practical reasons, it is restricted to those organisms that were introduced deliberately by people, following Zimmerman (1948). Thus, the expression "accidentally introduced" is not accepted. Propagules arrive either by **immigration** [of their own volition, whether or not they were hitchhikers in cargoes moved by humans] or by **introduction** (i.e., deliberate introduction by humans). In this scheme, there is no such thing as accidental introduction. The practical reason for the decision not to use this expression is that it is often difficult to determine how an insect arrived in a new area. For example, when (Phyllocnistis citrella) was first detected in Florida, there was speculation about how it arrived: some people speculated that it had arrived on the winds of Hurricane Andrew, whereas others thought it arrived as a hitchhiker in citrus planting stock; there is no proof either way, and the most practical solution is to label it an immigrant (which merely indicates that it was not introduced deliberately).

11. **Naturalization**. By United States law, human immigrants may, within a few years, become naturalized United States citizens. By United States law, Amerindians are considered to be native Americans, although their ancestors immigrated from Asia, whereas descendants of European immigrants are not. Environmental conservationists seem to separate the fauna and flora present in North America in the year 1492 or thereabout ("pre-Columbian") from that accruing later ("post-Columbian"), labeling the former alone as native. The native Hawaiian fauna and flora descended from immigrants within the last five million years, but immigrants continue to arrive in Hawaii, some of them with no human help; will the latter be considered native some day? If so, will descendants of introduced species be considered native some day? If the determinant of this fuzzy concept (which at present seems thoroughly anthropocentric) be number of generations, then insects naturalize more rapidly than do humans, because they have more generations per unit time.

12. The expression **neoclassical biological control** was coined by Lockwood (1993, 1996) to explain a subset of the controversial kind of biological control advocated as "new associations" by Hokkanen and Pimentel (1984). There is controversy for two reasons. First, because many authors dispute the evidence presented by Hokkanen and Pimentel (1984) that biocontrol organisms that are not co-evolved with the host (or prey) have a more deleterious affect on it than do co-evolved biocontrol organisms. Second, because organisms that are not co-evolved obviously are not absolutely host-(or prey-)specific, whereas biocontrol practitioners are being challenged (because of claims of collateral damage to non-target organisms) to use only host-specific biocontrol agents.

13. The expression **parasitization** has been referred to as the action of parasites in attacking a host (perhaps at some level distinguishing it from parasitism). But its use in the literature has been so inconsistent that it now serves merely as a long-winded (jargon) expression where the shorter term **parasitism** should be preferred (see Frank and McCoy 1989).

14. The terms **insect pest** and **plant pest** are confusing. Both are commonly used, and the latter has become a legal term used in the United States Code (Plant Pest Act) and Code of Federal Regulations. Logic suggests that only one of those terms includes insects that are pests, but which one? Written by lawyers, it is unclear whether **plant pest** means plants that are pests (i.e., weeds), or pests of plants (i.e., phytophagous organisms) -- in fact the laws seem to use it both ways. The interests of clarity suggest use of 4 expressions: (1) **Pests of insects** (such as diseases of honeybees and silkworms), (2) **Pest insects** (insects that are pests), (3) **Pests of plants**, and (4) **Weeds** (pest plants, or pests that are plants).

15. The word **predaceous** is etymologically wrong. Although it is an entry in Webster's New International Dictionary and in Webster's Collegiate Dictionary, these entries serve merely to show what spellings are used. The etymologically correct spelling is **predacious**, with alternative **predatory** (see Frank and McCoy 1989). Predacious is one of a group of words (rapacious, ferocious, pugnacious are others) with ending -ious, and differing from botanical terms (herbaceous, foliaceous, rosaceous, etc.) with ending -eous.

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