Department of Agriculture, Miscellaneous Publication No 1443, Washington, DC, 103 pp. Available Online at http://www.sel.barc.usda.gov/Selhome/collpres/contents.htm

Collembola

An order of hexapods in the class Entognatha, and sometimes considered to be insects. They commonly are called springtails.

► Springtails

Colleterial Glands

Female insects commonly secrete glue that attaches the egg to a substrate. Also secreted in some cases are jelly-like materials, oothecae, or pods containing the individual eggs. The glands that secrete these are known by various names, including accessory, mucous, cement, and colleterial glands.

Colletidae

A family of bees (order Hymenoptera, superfamily Apoidae). They commonly are known as plasterer bees and yellow-faced bees.

► Wasps, Ants, Bees and Sawflies
► Bees

Collophore

A tube-like structure located ventrally on the first abdominal segment of springtails (Collembola).

Colobathristidae

A family of bugs (order Hemiptera, suborder Pentamorpha).

► Bugs

Coloburiscidae

A family of mayflies (order Ephemeroptera).

► Mayflies

Colonization

The introduction and establishment of a species, usually a beneficial insect, in a new geographic area or habitat.

Colony

A group of individuals, other than a mated pair, which rears offspring in a cooperative manner, and may construct a nest. (contrast with aggregation)

Colony Fission

Among social insects, the same as budding: multiplication of colonies by the departure from the parental nest of one or more reproductive forms accompanied by workers. Thus, the parental nest remains functional and new ones are founded.

Colony Odor

Weber, Donald C. 2008. "Colorado potato beetle" in Encyclopedia of Entomology, edited by John L. Capinera (2nd edition), Kluwer, Vol. 2, pp. 324-328.

Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae)

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Colorado potato beetle is the most important insect pest of potatoes in the northern hemisphere. Larvae and adults feed on potato foliage, and under many agricultural conditions the pest will completely defoliate the crop if not controlled. It is also a major pest of eggplant (aubergine) and tomato in some regions, as well as feeding on

solanaceous weeds such as horsenettle, *Solanum carolinense*. Although it is occasionally found on other nightshade crops such as peppers (*Capsicum*), tobacco, and husk tomato (*Physalis*), it cannot complete its life-cycle on these hosts.

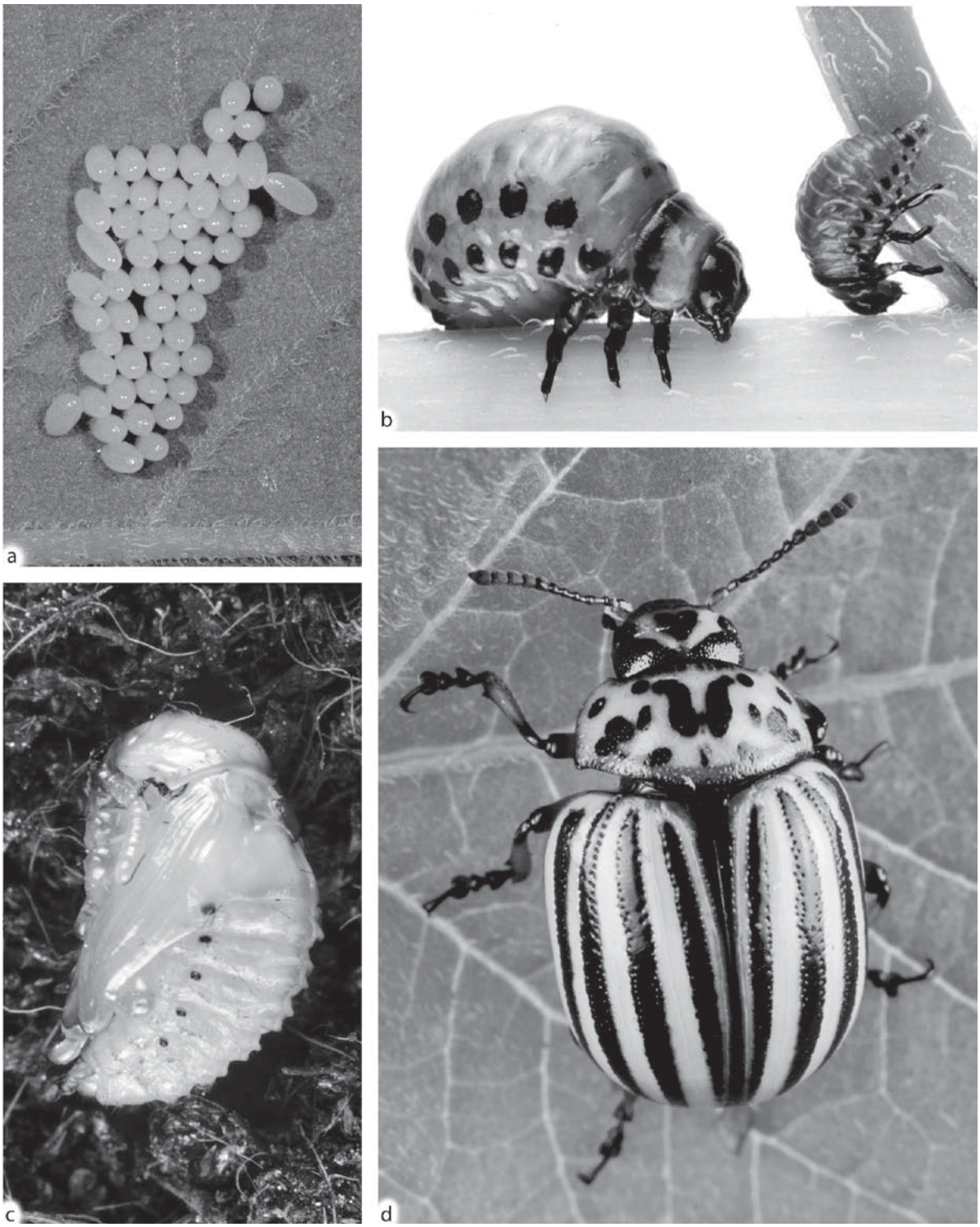
The original range of Colorado potato beetle was probably restricted to southwestern USA and/or northern Mexico, where the host plants were the spiny nightshade herbs *Solanum rostratum* (buffalobur) and *Solanum elaeagnifolium* (silverleaf nightshade). The species was described in 1824, but the first occurrence on potato was not reported until 1859 in Nebraska. From there it spread rapidly, especially eastward, reaching the Atlantic coast of North America in 1874. By then the potato crop was a staple food, and the spread of Colorado potato beetle infestation prompted early development of arsenical pesticides and application methods in the USA.

In 1870, responding in part to the threat of Colorado potato beetle introduction, Germany established the first-ever quarantine law followed within several years by other European countries. Following the eradication of numerous isolated European introductions, its establishment into France in 1921 initiated another rapid geographic invasion which now includes all of Europe (except for the United Kingdom, Ireland, and Scandinavia), continues through central Asia eastward into China, and threatens to spread into east and south Asia, where one-third of the world's potatoes are grown. The range is now about 8 million km^2 in North America and a like area in Eurasia. Climatically favorable areas not yet infested include east Asia, parts of south Asia temperate South America and Africa, Australia and New Zealand.

Colorado potato beetle adults are approximately 10 mm long, convex, with cream-yellow and black striped elytra, and variable black markings (Fig. 81) in the pronotum. Larvae are typically orange with two rows of black lateral spots, and as later instars are characteristically hump-backed in shape. Colorado potato beetle overwinters as the adult in the soil, and has from one to several generations per year, depending on temperature, photoperiod, and availability and quality of host plants. In the spring, overwintered adults emerge from the soil and begin their search for host plants to feed upon. This commences with walking, but after a few days beetles may take to flight. The yellow-orange eggs, laid on leaf undersides in masses of 20–60 (several hundred to a few thousand total per female), soon hatch into leaf-feeding larvae which eat about 40 cm^2 of foliage. The fourth instar larva drops to the ground and digs down a few cm to pupate in the soil, emerging 10–20 days later as a callow adult. Also a voracious leaf feeder, the imago consumes up to 10 cm^2 per day. Depending on food, photoperiod, and temperature, this young adult may mate and reproduce, or after feeding, bury itself 10–50 cm deep in the soil to spend months in diapause before emerging the next spring.

In areas where tomatoes abound, it has evolved an improved fitness on this plant, as in the southeastern USA and Uzbekistan. Even where it does not thrive on tomato, large numbers may damage this valuable crop. In contrast, potato plants can tolerate light to moderate defoliation at certain times of year, but without control, major to complete crop loss is common. A typical economic threshold is one adult equivalent per plant, where small larvae are counted as equivalent to 1/4 of one adult, and large larvae (3rd and 4th instars) equate to 2/3 of an adult. Yield impact is dependent on timing, variety, and other crop stresses.

In early years, control relied on hand-picking, but this gave way to arsenical insecticides and in the 1940s the more powerful synthetic chemical controls. No other agricultural pest better exemplifies evolution of resistance to insecticides. Within the first decade of DDT use, it was failing against Colorado potato beetle in the intensive potato-growing region of Long Island, New York, USA. Resistance followed to numerous other chlorinated hydrocarbons, organophosphates, carbamates, and pyrethroids. This sustained evolution of pesticide resistance has prompted development and use of additional novel chemical controls such as neonicotinoids and ecdysteroids, as well as transgenic crops incorporating high levels of beetle-specific



Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae), Figure 81
Colorado potato beetle (a) egg mass, (b) larvae, (c) pupa and (d) adult. (Egg mass photo by D. Weber; others by Doro Röthlisberger, Zoological Museum, University of Zurich.)

Cry3A BT toxins (derived from *Bacillus thuringiensis*). Transgenic potatoes were developed and introduced as the cultivar "Newleaf" in the 1990s, later also incorporating resistance to important aphid-transmitted potato viruses. Yet this highly effective tactic met with a mixed and then negative reception, first because it was introduced contemporaneously with an effective and broader-spectrum systemic insecticide, imidacloprid, and later because large multinational processors decided that using transgenic potatoes would risk consumer opposition across their global markets. Two years after registration in the US, major buyers announced plans to discontinue Newleaf purchases, and commercial sales have been discontinued. Transgenic technology continues with limited field trials in eastern Europe, and may be commercialized in the future. One prerequisite for sustainable use, as with chemical controls, is the implementation of resistance management plans.

Periodic failure of chemical controls has prompted research into a variety of alternatives ranging from pedestrian to peculiar. These include native and introduced biological controls, crop rotation, cover crop mulches, trap crops, trenches to disrupt crop colonization, early planting, late planting, and multi-row propane-fueled flamers and crop vacuums. Collectively and as complements to chemical control, these are essential tactics to manage the pest and help avert resistance.

For an insect that is the focus of thousands of published scientific articles, there is still surprisingly much to learn. In just the past few years, plant-based attractants as well as a male-produced aggregation pheromone, (*S*)-3,7-dimethyl-2-oxo-6-octene-1,3-diol, have been discovered. The exact role that these behaviorally active substances will play in Colorado potato beetle management remains to be seen, but perhaps in combination with selective toxins and/or antifeedants, a push-pull behavioral strategy can succeed in suppressing the Colorado potato beetle instead of whole-field treatments which have historically failed due to selection of resistance.

Natural enemies of Colorado potato beetle may sometimes keep the pest below economic threshold, but not reliably in most current cropping systems. Predatory stink bugs (*Podisus* and *Perillus*) as well as several species of generalist Coccinellidae and Carabidae, spiders and harvestmen are common predators. During the 1980s, the egg parasitoid wasp *Edovum puttleri* was introduced to the USA from Colombia (where it is native on *L. undecemlineata* (Stål)), and enjoyed success as an inundative biocontrol in the high-value eggplant crop. This parasitoid is not winter-hardy. Rearing efforts ceased with the advent of the systemic neonicotinoid imidacloprid.

Two of the most promising natural enemies native to North America are quite poorly studied. *Lebia grandis* is a carabid ground beetle predator of Colorado potato beetle eggs and larvae as an adult, whose larvae are ectoparasitoids of Colorado potato beetle pupae. The newly hatched larvae locate the Colorado potato beetle host soon after it buries itself to pupate, then obtain their entire larval food requirement from a single host pupa, emerging weeks later as blue-metallic and orange, very mobile and hungry adult predator beetles. Two species of tachinid parasitoid flies of the genus *Myiopharus* attack larvae or in the fall even Colorado potato beetle adults, where they overwinter as an early-instar larva inside their host, then develop and emerge the next season as an adult fly. *Beauveria bassiana* has potential to suppress Colorado potato beetle populations under some conditions, and commercial formulations have been developed. If the agroecosystem can somehow better nurture natural enemies, especially early in the season before Colorado potato beetle damage the crop, then Colorado potato beetle management may not so frequently require costly and sometimes troublesome insecticidal inputs.

Crop rotation is consistently an effective means to delay and reduce colonization of overwintered adults. But in many cases, land tenure and intensive culture may prevent farmers from rotating the several hundred meters which constitute an effective separation in successive years. Yet even unrotated crops are amenable to border treatments, trap crops or trenches to thwart beetle colonization, because

many adults overwinter in wooded or other non-crop areas adjacent to crop fields. Physical controls of flaming and vacuuming have enjoyed limited success against the pest. Rye straw or other killed cover crops suppress Colorado potato beetle populations, probably by a combination of abiotic and biotic effects. One novel cultural-physical control uses late-maturing trap crops to attract beetles to concentrated overwintering areas which are then stripped of their snow and mulch covering in midwinter to enhance diapause mortality.

Colorado potato beetle is one of the most frequently used bioassay insects for toxicological and physiological research, and usually the first beetle to be tested with candidate insecticides. It is easily maintained on a potato diet, hosting few diseases in the lab, and is also amenable to semi-artificial diet, which aids in precisely controlling its nutrition. Colorado potato beetle has played a key role in development of concepts of host-plant location and selection, host shifts, molecular and population mechanisms of pesticide resistance, gene flow, and integrated pest management. There is also active research on conventional and engineered crop resistance, neurophysiology, dispersal behavior, biochemical and molecular reaction of host plants to Colorado potato beetle feeding, digestive, microbial and immunological defenses of Colorado potato beetle and, of course, novel natural and synthetic toxins and antifeedants.

Providing sustainable control options requires not only laboratory and molecular insights into the mechanisms, but also ecological and behavioral insights, especially into the movement of beetles within and between fields which could lead to the spread or suppression of pesticide resistance genes in agricultural populations. The quantification of gene flow and frequencies, which in turn depends on selection, dispersal and reproduction, provides the basis for rational deployment of refugia in resistance management. Questions of movement are also critical to effective employment of crop rotation and pest colonization in a variety of regional cropping systems. In some areas, the beetle flies frequently. In others, it flies rarely. In Siberia, it buries deeply over winter, while in milder areas, it buries less deeply. Some beetles delay emergence from diapause for years at a time. Researchers express both reverence and frustration at the variability in its behavior.

Just why is the Colorado potato beetle so flexible in responding to changing ecology and toxicology? The reason may lie in its evolutionary history of genetic and biochemical diversity in ecological and evolutionary pursuit of toxicologically complex and ephemeral groups of host plants. This beetle reinforces the need for flexible and integrative thinking in developing pest management strategies: one tactic alone will not quell it for long. Witness the latest entry, the chloronicotinyl imidacloprid, starting to fail after about 10 years of intensive use in the eastern USA. Integration of multiple effective tactics will continue to be essential for an intelligent and sustainable approach to management of the formidable Colorado potato beetle.

► Potato Pests and Their Management
► Vegetable Pests and Their Management

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Colorado Tick Fever

A viral disease transmitted by ticks in the USA.
► Ticks

Columnar Cells

The tall, and generally most numerous cells, of the midgut. They conduct most of the enzyme secretion and absorption of digested products.

Colydiidae

A family of beetles (order Coleoptera). They commonly are known as cylindrical bark beetles.
► Beetles

Comb

A layer of brood cells or cocoons produced by social insects and clustered together in a regular arrangement.

Comb-Clawed Beetles

Members of the family Alleculidae (order Coleoptera).
► Beetles

Commensalism

An association between two organisms from distant taxa that harms neither and benefits at least one.

Common Fleas

Members of the family Pulicidae (order Siphonaptera).
► Fleas

Common Name

A vernacular name, reflecting the language of a particular country, as opposed to a scientific name, which is universal.
► Common (Vernacular) Names of Insects

Common Oviduct

A median tube (median oviduct) of the female genital tract (Fig. 82) that leads from the lateral oviducts to the cloaca (vagina).
► Reproduction

Common Sawflies

Members of the family Tenthredinidae (order Hymenoptera, suborder Symphyta).
► Wasps, Ants, Bees and Sawflies

Common Scorpionflies

Members of the family Panorpidae (order Mecoptera).
► Scorpionflies

Common Skimmers

A family of dragonflies in the order Odonata: Libellulidae.
► Dragonflies and Damselflies

Common Stoneflies

Members of the stonefly family Perlidae (order Plecoptera).
► Stoneflies