CANDIDATE ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: Drosophila digressa

COMMON NAME: No common name

LEAD REGION: Region 1

INFORMATION CURRENT AS OF: February 2003

STATUS/ACTION (Check all that apply):
___ New candidate
_X_ Continuing candidate
    _X_ Non-petitioned
    ___ Petitioned - Date petition received: ___
        ___ 90-day positive - FR date: ___
        ___ 12-month warranted but precluded - FR date: ___
    ___ Listing priority change
        Former LP: ___
        New LP: ___
Latest date species first became a Candidate: February 28, 1996
___ Candidate removal: Former LP: ___ (Check only one reason)
    ___ A - Taxon more abundant or widespread than previously believed or not subject to a degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
    ___ F - Range is no longer a U.S. territory.
    ___ M - Taxon mistakenly included in past notice of review.
    ___ N - Taxon may not meet the Act's definition of "species."
    ___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Insect; Drosophilidae (Pomace Fly)

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Hawaii

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Hawaii

LEAD REGION CONTACT (Name, phone number): Scott McCarthy (503/231-6131)

LEAD FIELD OFFICE CONTACT (Office, name, phone number): Pacific Islands Office, Mike Richardson (808/541-3441)

BIOLOGICAL INFORMATION:

Perhaps the most remarkable group of Hawaiian insects, and that which most typifies insect evolution in Hawaii, are the flies in the family Drosophilidae (Williamson 1981). To date, 511 species of Hawaiian Drosophilidae have been named and described. An additional 250-300 species are already in the collection at the University of Hawaii and await taxonomic treatment, and new species are still being discovered from localities not previously sampled. It is estimated that as many as 1,000 species may be present in native Hawaiian ecosystems (Kaneshiro 1993). This family in Hawaii represents one of the most remarkable cases of adaptive radiation of any group of animals over the entire world (Hardy and Kaneshiro 1981). They are distributed throughout the high islands of the archipelago, displaying not only a highly characteristic single island endemism, but also extraordinary morphological diversity along with adaptations that show their intimate ecological relationship to the native flora (Carson and Yoon 1982).

Drosophilidae are similar in structure to other flies in that adults have three main body parts--a head, thorax, and abdomen. A pair of antennae arises from the front of the head, between the eyes. The single pair of wings and three pairs of legs are attached to the thorax. The abdomen is composed of multiple segments.

The general life cycle of Hawaiian Drosophilidae is typical of that of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow they molt (shed their skin) through three successive stages (instars); when fully grown the larvae change into pupae (a resting form) in which they metamorphose and emerge as adults. The courtship and mating behavior of some species (Hawaiian picture-wings) are extremely elaborate with exaggerated visual cues displayed by the males. These flies have been referred to as the “birds of paradise” of the insect world because of their spectacular courtship displays and territorial defense. Males occupy territories which serve as mating arenas to which receptive females are attracted for mating. The males fight among themselves for the best territories and establish a dominance hierarchy like some birds and mammals.

The Hawaiian Drosophilidae have also radiated and adapted ecologically to a tremendous diversity of ecosystems ranging from desert-like habitats where the soil is powdery dry, to rain forests with lush, tree-fern jungles, and in swampland perpetually shadowed by rain clouds and with vegetation that is burdened with dripping, moss-laden branches. While the larval stages of most species are saprophytic, feeding on decaying vegetation such rotting leaves, bark, flowers, and fruits, some have become highly specialized, being carnivorous on egg masses of spiders, or feeding on green algae growing underwater on boulders in streams. As a group, the Hawaiian Drosophilidae appear to be ubiquitous and can be found in most of the natural communities in Hawaii.

Unlike most Hawaiian insects that remain obscure, typically known only from their original taxonomic descriptions, every aspect of Hawaiian Drosophilidae biology has been researched, including their internal and external morphology, behavior, ecology, physiology, biochemistry, the banding sequence of giant chromosomes, as well as detailed analyses of the structure of the DNA molecules. More than 80 research scientists and over 350 undergraduates, graduate students, and post-doctoral fellows have participated in research on the Hawaiian Drosophilidae, resulting in over 600 scientific publications on the biology of these flies. The Hawaiian Drosophilidae is arguably the most intensively studied group of all terrestrial Hawaiian

organisms.

Research on Hawaiian Drosophilidae has resulted in the development and testing of new theories of evolutionary biology (Bradley et al. 1991; Carson 1971, 1982a; Kaneshiro 1976, 1980, 1987, 1989). Ideas on speciation and island evolution developed from studies on Hawaiian Drosophilidae are now referenced in most modern text books of biology and evolution (e.g. Ridley 1993).

The Hawaiian Drosophila Project at the University of Hawaii has coordinated and cooperated in most of the research on the Hawaiian Drosophilidae. It has also maintained extensive collection records of these species. These records form the basis for much of the data used to develop this proposed rulemaking. Three decades of collection work are maintained in permanent files of the Hawaiian Drosophila Project within the University of Hawaii's Center for Conservation Research and Training. Also, collection notes of the individual researchers on the project contain extensive records of host plant associations of most of these species.

Biologists have observed a general decline of the Hawaiian Drosophilidae along with other components of the native ecosystem. As noted by Spieth (1980), during the early part of the century, the Tantalus area behind the city of Honolulu was the major spot for collecting Drosophila. By 1963, the majority of the native Drosophila species in this area had been exterminated, apparently due to intrusion of exotic vegetation, and predation by ants. Quantitative sampling since 1971 has demonstrated dramatic declines in the abundance of some species and in other cases local extirpations (Carson 1986; Foote and Carson 1995). A review of the data collected by the Hawaii Drosophila Project and assessment of the threats to remaining populations suggests that at least 14 species of these flies are presently threatened with extinction.

Drosophila digressa is restricted to the island of Hawaii, where it breeds only in the bark of Charpentiera trees. This species is known from three populations. The sizes of these populations have not been determined, but numbers are not large and have significantly declined. Threats to this Hawaiian picture-wing include habitat degradation from ungulates, alien weeds, and predation by ants and alien wasps.

THREATS:

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

Native vegetation on all the main Hawaiian islands has undergone extreme alteration because of past and present land management practices including ranching, deliberate introduction of alien plants and animals, and agricultural development (Cuddihy and Stone 1990). Some of the primary threats facing this species are ongoing and threatened destruction and adverse modification of habitat be feral animals and alien plants.

Animals such as pigs, goats, axis deer, black-tailed deer, and cattle were introduced either by the early Hawaiians (pigs) or more recently by European settlers (all ungulate species) for food and/or commercial ranching activities. Over the 200 years following their introduction, their numbers increased and the adverse impacts of feral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect of trampling and grazing native plants, feral

ungulates have contributed significantly to the heavy erosion still taking place on most of the main Hawaiian islands.

Sus scrofa (pigs), originally native to Europe, Africa, and Asia, were introduced to Hawaii by the Polynesian ancestors of Hawaiians, and later by western immigrants. The pigs escaped domestication and invaded primarily wet and mesic forests and grasslands of Kauai, Oahu, Molokai, Maui, and Hawaii. While foraging, pigs root and trample the forest floor, encouraging the establishment of alien plants in the newly disturbed soil. Pigs also disseminate alien plant seeds through their feces and on their bodies, accelerating the spread of alien plants through native forest (Cuddihy and Stone 1990; Stone 1985). Foote and Carson (1995) experimentally demonstrated the detrimental affects of feral pigs on Hawaiian picture-wings in wet forest habitat on the island of Hawaii.

Most of the plants which serve as breeding sites for Hawaiian picture-wings occur as understory vegetation beneath the canopy of the Metrosideros polymorpha (>ohi>a) and koa trees, and are affected by competition with alien weeds. Hawaiian picture-wing species are threatened by loss of host plants due to competition with one or more alien plant species. The most significant of these appear to be Schinus terebinthifolius (Christmasberry), Psidium cattleianum (strawberry guava), Melinus minutiflora (molasses grass), Pennisetum setaceum (fountain grass), Clidemia hirta (Koster's curse), Lantana camara (lantana), Rubus argutus (prickly Florida blackberry), Passiflora mollissima (banana poka), and Rubus ellipticus (Himalayan raspberry).

Strawberry guava, an invasive shrub or small tree native to tropical America, has become naturalized on all of the main Hawaiian islands. Like Christmasberry, strawberry guava is capable of forming dense stands that exclude other plant species (Cuddihy and Stone 1990). This alien plant grows primarily in mesic and wet habitats and provides food for several alien animal species, including feral pigs and game birds, which disperse the plant's seeds through the forest (Smith 1985; Wagner et al. 1985). Strawberry guava is considered one of the greatest alien plant threats to Hawaii's rain forests and is known to pose a direct threat to Drosophila digressa. Strawberry guava is a major invader of forests in windward Hawaii where it often forms single-species stands.

Prickly Florida blackberry was introduced to the Hawaiian Islands in the late 1800s (Haselwood and Motter 1976). The fruit are easily spread by birds to open areas where this plant can form dense, impenetrable thickets (Smith 1985). The habitat of Drosophila digressa is threatened by this noxious weed.

A recent introduction to the Hawaiian Islands, yellow Himalayan raspberry is rapidly becoming a major weed pest in wet forests, pastures, and other open areas on the island of Hawaii. It forms large thorny thickets and displaces native plants. Its ability to invade the understory of wet forests enables it to fill a niche presently unoccupied by any other major wet forest weed in Hawaii. This has resulted in an extremely rapid population expansion of this alien plant in recent years. Yellow Himalayan blackberry threatens the habitat of Drosophila digressa.

A vine in the passionflower family, banana poka was introduced to the islands in the 1920s, probably as an ornamental. This vine is extremely detrimental to certain wet forest habitats of Kauai, Maui, and Hawaii. Heavy growth of this vine can cause damage or death to the native trees by overloading branches, causing breakage, or by forming a dense canopy cover,

intercepting sunlight and shading out native plants below. This weed threatens Drosophila digressa.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

Not applicable.

C. Disease or predation.

Over 2,500 alien arthropods are now established in Hawaii (Howarth 1990; Howarth et al. 1995; Nishida 1994), with a continuing establishment rate of 10-20 new species per year (Beardsley 1962, 1979). Many of these alien species have severe affects on the native Hawaiian insect fauna (Asquith 1995). Species of social Hymenoptera (ants and some wasps) and parasitic wasps pose the greatest threat to the Hawaiian picture-wings. Ants and other social insects frequently dominate the ecologies of tropical ecosystems and strongly influence the evolution of certain plants and animals. All of the native Hawaiian arthropods, including the Hawaiian picture-wings, evolved without the predation influence of ants or social wasps, and the arrival of these new groups has been devastating.

Ants can be particularly destructive predators because of their high densities, recruitment behavior, aggressiveness, and broad range of diet (Reimer 1993). These attributes allow some ants to affect prey populations independent of prey density, and ants can therefore locate and destroy isolated populations and individuals (Nafus 1993). At least 36 species of ants are known to be established in the Hawaiian Islands, and particularly aggressive species have had severe effects on the native insect fauna (Zimmerman 1948). By the late 1870s, the big-headed ant (Pheidole megacephala) was present in Hawaii and its predation on native insects was noted by the early Hawaiian naturalist R.C.L. Perkins (1913)—"It may be said that no native Hawaiian Coleoptera insect can resist this predator, and it is practically useless to attempt to collect where it is well established. Just on the limits of its range one may occasionally meet with a few native beetles, e.g.--species of Plagithmysus, often with these ants attached to their legs and bodies, but sooner or later they are quite exterminated from these localities." With few exceptions, native insects, have been eliminated from areas where the big-headed ant is present (Perkins 1913; Gagne 1979; Gillespie and Reimer 1993), and it has been documented to completely exterminate populations of native insects.
The Argentine ant (Iridomyrmex humilis) was discovered on the island of Oahu in 1940 and is now established on all the main islands. Unlike the big-headed ant, the Argentine ant is primarily confined to higher elevations (Reimer et al. 1990). This species has been demonstrated to reduce populations or even eliminate native arthropods at high elevations in Haleakala National Park on Maui (Cole et al. 1992). While this species does not disperse by flight, colonies are moved about with soil and construction material, and a colony was recently discovered on an isolated peak on the island of Oahu under a radio tower.

The long-legged ant (Anoplolepis longipes) appeared in Hawaii in 1952 and now occurs on Oahu, Maui, and Hawaii (Reimer et al. 1990). It inhabits low elevation (less than 600 m [2,000 ft]), rocky areas of moderate rainfall (less than 250 cm [100 in.] annually) (Reimer et al. 1990). Direct observations indicate that Hawaiian arthropods are susceptible to predation by this species (Gillespie and Reimer 1993) and Hardy (1979) documented the disappearance of most native insects from Kipahulu Stream on Maui after the area was invaded by the long-legged ant.

At least two species of fire ants, Solenopsis geminita and Solenopsis papuana, are also important threats (Reagan 1986; Gillespie and Reimer 1993) and occur on all the major islands (Reimer et al. 1990). Solenopsis geminita is known to be a significant predator on pest fruit flies in Hawaii (Wong and Wong 1988). Solenopsis papuana is the only abundant, aggressive ant that has invaded intact mesic forest above 600 m (2,000 ft) and is still expanding its range in Hawaii (Reimer 1993).

Numerous other ant species are recognized as threats to native invertebrates, and additional species become established almost yearly. While the larvae of most of the Hawaiian picture-wings feed deep in the substrate of the host plant, they emerge and move away to pupate in the ground, thus exposing themselves to predation by ants. Upon newly emerging as adults, these flies are particularly susceptible to predation and adult picture-wings have been observed with a ants attached to their legs (Kaneshiro and Kaneshiro 1995).

Another group of social insects that are voracious predators and were originally absent from Hawaii are yellowjacket wasps (Hymenoptera: Vespidae). In 1977, an aggressive race of the western yellowjacket (Paravespula pennsylvanica) became established in Hawaii and is now abundant at most higher elevations (Gambino et al. 1990). In Haleakala National Park on Maui, yellowjackets were found to forage predominantly on native arthropods (Gambino et al. 1987, 1990; Gambino and Loope 1992). Overwintering yellowjacket colonies in Hawaii can produce over half a million foragers that consume tens of millions of arthropods, and there is evidence for localized reduction in native arthropod abundance (Gambino and Loope 1992). Yellowjackets have been observed preying on Hawaiian picture-wings Kaneshiro and Kaneshiro 1995), and the establishment of this species on the island of Hawaii corresponded with a significant decline in several species of Hawaiian picture-wings (Carson 1982b, 1986; Foote and Carson 1995). Yellowjackets pose a serious threat to all Hawaiian picture-wing species in this proposed rulemaking.

Hawaii also has a limited number of native parasitic Hymenoptera (wasps), with only species of Eucoiliidae recorded to utilize Hawaiian picture-wings as hosts. Several species of alien braconid wasps, Diaschasmimorpha tryoni, D. longicaudatus, Opius vandenboschi, and Biosteres arisanus, were purposefully introduced into Hawaii to control several species of pest tephritid fruit flies (Funasaki et al. 1988). However, none of these wasps are specific to the pest flies, but are known to attack other species of flies, including native Hawaiian Tephritidae. While these wasps have not been recorded from Hawaiian picture-wings, and may not successfully develop in Drosophilidae, females will sting any fly larva available and can cause significant mortality (T. Duan, University of Hawaii, pers. comm., 1995). Inundative releases of these wasps or introductions of new species pose potential threats to Hawaiian picture-wings.

D. The inadequacy of existing regulatory mechanisms.

No current protection exists.

E. Other natural or manmade factors affecting its continued existence.

Alien parasitic wasps pose a threat to the Hawaiian picture-wings, and some alien species are purposefully introduced by Federal and State agencies for biological control of pests flies.

Federal regulations for controlling the introduction of biocontrol agents are inadequate (Lockwood 1993). The U.S. Environmental Protection Agency (EPA) under the authority of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), regulates biological control agents as pesticides. However, EPA only regulates microorganisms (bacteria, fungi, protozoa and viruses). EPA has exempted all other organisms from requirements of FIFRA becuase it has determined that they are adequately regulated by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS).

Although the State of Hawaii requires that new introductions be reviewed by special committees before release (HRS Chapt. 150A), post-release biology and host range cannot be predicted from laboratory studies (Gonzalez and Gilstrap 1992; Roderick 1992) and the purposeful release or augmentation of any dipteran predator or parasitoid is a potential threat to Hawaiian picture-wings.

FOR RECYCLED PETITIONS:

a. Is listing still warranted? ___
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? ___
c. Is a proposal to list the species as threatened or endangered in preparation? ___
d. If the answer to c. above is no, provide an explanation of why the action is still precluded

LAND OWNERSHIP: This species presently occurs on State and Federal lands.

PRELISTING: The Pacific Islands Office has funded BRD to conduct a demonstration project for control of *Paravespula* wasps on the island of Hawaii.

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LISTING PRIORITY (* after number)

THREAT

Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2*
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude:

Imminence:

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes to the candidate list, including listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all additions of species to the candidate list, removal of candidates, and listing priority changes.

Approve: Rowan Gould March 6, 2003
Regional Director, Fish and Wildlife Service Date

Concur: _____ _____
Director, Fish and Wildlife Service Date

Do not concur: _____ _____
Director, Fish and Wildlife Service Date

Director's Remarks:

-

-

Date of annual review: 2/03
Conducted by: _____

Comments:

-

-