ODONATA AT RISK IN CONTERMINOUS UNITED STATES AND CANADA

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32 spp. (8% of the odon. fauna) considered to be at risk in the United States and Canada are assigned to *Red Data Book* categories as follows: Rare-20 (62%), Vulnerable-5 (16%), Endangered-3 (9%), Insufficiently known-3 (9%), Probably extinct-1 (3%). Most (82%) of the threatened spp. are associated with flowing water. The loss of high-quality, undisturbed streams is the most significant factor endangering odonates in the US and Canada. The threatened spp. occur in 3 eastern Canadian Provinces and in 31 states, most of which are east of the Mississippi River. There is no one small area where conservation efforts could be marshalled for the simultaneous protection of more than one narrow endemic sp. However, the southeastern Highlands and the southern Gulf Coast are considered important for future conservation efforts.

INTRODUCTION

As early as 1922, WILLIAMSON was concerned with reductions of *Somatochlora* populations in Indiana. However, there seems to have been no further mention of reductions until COOK (1975) wondered if some North American species were already extinct. CARLE (1979a) listed Anisoptera at risk in Virginia, and DUNKLE & WESTFALL (1982) discussed rare and threatened Odonata of Florida. There has been no treatment of threatened species within the entire Order for all of conterminous United States and Canada. I summarized

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Odonata at risk in North America at the inaugural meeting of the Odonata Specialist Group, International Union for Conservation of Nature held in Kyoto, Japan, August, 1980. The following discussion resulted from this effort, although it differs substantially from the original presentation. It should provide a much needed summary of the rare and threatened Odonata of North America.

METHODS

After lists of species thought to be at risk were prepared, the assistance of colleagues was sought. Their opinions, added to my own, produced a lengthy list which was gradually shortened as definitions for inclusion in the *Red Data Book* were applied. In spite of diversity of opinion, I believe that the following presentation will have general support.

The *Red Data Book* categories provide practical criteria for describing the severity of stress faced by each species. Because assigning each to a category is a primary purpose of this paper, it is necessary to present the *Red Book* definitions, viz.:

Endangered: Taxa in danger of extinction whose survival is unlikely if the causal factors continue operating;

Vulnerable: Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating:

Rare: Taxa with small world populations under no known immediate threat;

Threatened: This term is used in a genereal sense to include species that are in any of the above categories but for which there is not enough information to say which category is appropriate;

Insufficiently known: Species of complex genera thought to be under threat and whose members are not easily recognized.

In the discussion below, species are grouped by family, but in Table I they are grouped according to their *Red Book* categories. Within the family, genera and species are alphabetical. Abbreviations used are: US for United States, the US Post Office two-letter abbreviations for the various states, Co. for the US counties, and FSCA for the Florida State Collection of Arthropods.

ANNOTATIONS FOR THE THREATENED SPECIES

Protoneuridae

NEONEURA AARONI CALVERT, 1903

This is one of only two members of this Neotropical family to reach the US. It is reported from Nueces Co., southern TX (CALVERT, 1901-1908), and there are specimens in FSCA from Caldwell, Goliad, Gonzales, Victoria Cos., also in southern TX. This species has not been reported from Mexico and the one very young specimen from Guatemala may have been misidentified (CALVERT, 1919). It is apparently limited to slow moving streams in southern TX. Here, 91 specimens were collected June 1958 (FSCA), but only two were taken from the same area June 1966. A category of **rare** is proposed.

Coenagrionidae ENALLAGMA RECURVATUM DAVIS, 1913

This species is recorded only from a small area along the heavily populated and industrialized Atlantic Coast from Cape Cod to southern NJ. It is reported from: Long Island, NY, and Ocean Co., NJ (DAVIS, 1913); Cape Cod, MA (GIBBS & GIBBS, 1954); the Pine Barrens, NJ (BEATTY, 1945). Also, there is a pair in FSCA from Burlington Co., NJ. Gibbs & Gibbs found it associated with sand and bog areas, habitats certainly imperiled within the recorded range of the species. Because environmental pressure will increase in the near future, a category of vulnerable is appropriate.

ISCHNURA GEMINA (KENNEDY, 1917)

This species, confined to a small coastal region in the San Francisco Bay Area, CA, at highly disturbed urban sites, is threatened by habitat modification, pollution, and other human activity. GARRISON & HAFERNIK (1981a) mapped the distribution which extends from Point Reyes, Marin Co. in the north to Santa Cruz Co. in the south, and there are specimens in FSCA from adjacent Monterey Co. KENNEDY (1917) described the species from only 23, 19, and until 1978 it was often considered extinct. At that time there were only 213, 169in the world's collections. GARRISON & HAFERNIK (1981a, 1981b) then found the species at eight additional localities, all in the San Francisco Bay Area and all but one in urban areas liable to habitat alteration. One population has now become extinct due to new construction, another experiences heavy foot and motorbike traffic, and the site of another was recently dredged. Each of two areas supporting the largest populations does not exceed 1 ha, and two other sites are moderately to heavily polluted. A *Red Book* listing of **endangered** is clearly indicated.

Gomphidae GOMPHUS (GOMPHURUS) ADELPHUS SELYS, 1857

New synonymy will show that this species, long considered to be very rare (NEEDHAM & WESTFALL, 1955) or even extinct (COOK, 1975), is actually neither scarce nor in any way threatened.

GOMPHUS (GOMPHURUS) CONSANGUIS SELYS, 1879

It is associated with small spring-fed streams (WESTFALL & TROGDON, 1962), and is limited to a small area in the southern Appalachian Mountains having been reported from: Scott, Washington Cos., VA; Campbell, Polk,

Sullivan Cos., TN; Walker Co., GA; Blount Co., AL (F.L. Carle and S.W. Dunkle, pers. comm; LOUTON, 1982a; WESTFALL & TROGDON, 1962). Records from NC and PA have been shown (WESTFALL & TROGDON, 1962) to be erroneous. CARLE (1979a) considered the species endangered in VA, and C. Cook (pers. comm.) thought it threatened elsewhere as well. Because there is no known specific threat, a category of **rare** seems appropriate.

GOMPHUS (GOMPHURUS) OZARKENSIS WESTFALL, 1975

This species seems to be restricted to western AR and southeasteren OK where it is associated primarily with highland areas. It occurs in: Franklin, Fulton, Marion, Montgomery, Pike, Sevier, Washington, Yell Cos., AR (HARP & RICKETT, 1975; WESTFALL, 1975, 1977; FSCA), and in Pushmataha Co., OK (LOUTON, 1982a). The species has been collected from streams (WESTFALL, 1975), but no further details have been recorded. Tourism in the Ozark Mountains may pose a future threat which is not yet manifest, so a category of **rare** is suggested.

GOMPHUS (GOMPHURUS) SEPTIMA WESTFALL, 1956

It was described from specimens from the Warrior River, Tuscaloosa Co., AL (WESTFALL, 1956). After over 26 years this seems to be the only published locality, however there are specimens in FSCA from Chatham Co., NC, quite a distance from the type locality. The type series was from a river, but nothing else on habitat is recorded. CARLE (1979a) considered the species endangered and it is certainly one of the scarcest in the US, yet because there is only the general threat to all riverine species, a category of **rare** is proposed.

GOMPHUS (GOMPHUS) DIMINUTUS NEEDHAM, 1950

It is recorded from rather widely scattered localities in southeastern US: Moore Co., NC (NEEDHAM, 1950; WESTFALL, 1965); Chesterfield Co., SC (WESTFALL, 1965; WHITE et al., 1980); Santa Rosa Co., FL (DUNKLE & WESTFALL, 1982); TN (C. Cook, pers. comm.). Dunkle & Westfall reported it from undisturbed acid streams with considerable sphagnum, and considered it threatened in FL. A category of **rare** is indicated when the total range is taken into account.

GOMPHUS (GOMPHUS) HODGESI NEEDHAM, 1950

Although recorded from four states, this species is actually restricted to a small Gulf Coastal strip from: St. Tammany Parish, southeastern LA; through George,

Greene, Hancock, Wayne Cos., MS; through Baldwin, Escambia Cos., AL; east to Calhoun and Gulf Cos., FL (BICK, 1957; DUNKLE & WESTFALL, 1982; NEEDHAM, 1950; WESTFALL, 1965; Cornell Univ.; FSCA). The species is associated with small, clean, sand-bottomed streams (BICK, 1957; DUNKLE & WESTFALL, 1982). The latter found it rare in FL, and this seems to be an appropriate *Red Book* listing.

GOMPHUS (HYLOGOMPHUS) CAROLINUS CARLE, 1979

This taxon was described from specimens from sandy streams in Chesterfield Co., SC and nearby Montgomery and Moore Cos., NC by CARLE (1979b) who stated that discovery of additional populations of this "seemingly rare" species may show it to be a subspecies of *G. parvidens* Currie. The only additional locality is from adjacent Richmond Co., NC (LOUTON, 1982a). Because of Carle's reservation, and because the description is too recent to assure that the distribution is as restricted as the localities indicate, a listing of **insufficiently known** is suggested.

GOMPHUS (HYLOGOMPHUS) GEMINATUS CARLE, 1979

Like G. hodgesi, this species is limited to a narrow Gulf Coastal strip in: Decatur Co., southwestern GA; Escambia Co., southern AL; Calhoun, Gadsden, Liberty, Okaloosa, Santa Rosa, Walton Cos., in the FL Panhandle (CARLE, 1979b; DUNKLE & WESTFALL, 1982; LOUTON, 1982a). This species of clear Coastal Plain streams (LOUTON, 1982a), tardily discovered in a rather well studied area, was considered rare in FL by Dunkle & Westfall, and this seems to be an appropriate general listing.

GOMPHUS (HYLOGOMPHUS) PARVIDENS CURRIE, 1917

It occurs in a long strip from Prince Georges Co., MD, through the mountains of VA, NC (CARLE, 1979b) and GA (LOUTON, 1982a), to Hale and Perry Cos., AL (BICK & BICK, 1983). It is associated with rapids of swiftly flowing streams (CURRIE, 1917; WESTFALL, 1942; NEEDHAM & WESTFALL, 1955) and with large, cool, sand and gravel-bottomed streams of apparent high water quality (LOUTON, 1982a). CARLE (1979a) considered this species **rare** in VA, and this seems to be an appropriate *Red Book* listing.

OPHIOGOMPHUS ACUMINATUS CARLE, 1981

This recently described species is known from four adults and nine larvae, all from the same location in Lewis Co., TN (CARLE, 1981). These larvae were

from sparse gravel pockets in the fissures of a rock stream bed. LOUTON (1982b) described *O. bouchardi* from four adults and two exuviae from Dickson Co., TN, a short distance from the Carle locality. There is a postscript to his description indicating that his new species is likely to be conspecific with *O. acuminatus*. Regardless of the correct name to be applied to this taxon, it is evidently limited geographically and thus far very scarce in collections. A category of **rare** is appropriate.

OPHIOGOMPHUS ANOMALUS HARVEY, 1898

It was described from only 1 \Im from Penobscot Co., ME, but HARVEY (1901) recorded 75 pairs from the same locality. After this exceptionally large collection, there are no further records from ME despite extensive collecting in that State. STOHR (1918) reported the species from Quebec, and it is now recorded from two districts there and from three in Ontario (WALKER, 1934, 1941, 1958; ROBERT, 1963; HUTCHINSON & LAROCHELLE, 1977). WALKER (1958) recorded 1 \Im from Orange Co., NY, considered to be a stray, and HILSENHOFF (1972) added 1 \Im from Sawyer Co., WI. This recorded distribution (Ont., Que., ME, NY, WI) suggests a widespread species, but it has not been reported from ME since 1901 and is represented in NY and WI each by a single specimen. WALKER (1958), who found this species in the field only once, considered it very local in the Ottawa Valley of Canada. This is a species of clear, rapid streams and large rivers (WALKER, 1941). C. Cook (personal communication) thought it endangered, and since it will probably soon move into that category, a listing of vulnerable seems appropriate.

OPHIOGOMPHUS ARIZONICUS KENNEDY, 1917

This southernmost species of the genus was described from two adults collected in Cochise Co., southeastern AZ (KENNEDY, 1917). There appears to have been no other published record until DUNKLE (1975, 1976) reported it and described the larva from Catron Co., NM, a short distance northeast of the AZ locality. Specimens are in FSCA from Coconino and Apache Cos., AZ. DUNKLE (1976) collected larvae from a clear stream with exposed rocks and gentle rapids. Because this seldom collected species of mountain areas of the southwest appears to be protected for the time being by national forests and monuments, a category of **rare** is indicated.

OPHIOGOMPHUS EDMUNDO NEEDHAM, 1951

It was described from 13, NC (no further locality) and from 19, Inglenook, PA, both collected in 1892 (NEEDHAM, 1951). Thereafter, BEATTY &

BEATTY (1968) questioned the PA record, and the validity of the species was doubted (K.J. Tennessen, pers. comm.). CARLE (1979a) found the species endangered. In 1981, having discovered and figured a second male whose locality label was only NC, as in the holotype, he treated it as a valid species. *O. edmundo* is known from only three individuals, and its last recorded collection date is 1892. The species is **probably extinct**, but CARLE (1981) suggested that it may occur in the small streams of western NC.

OPHIOGOMPHUS HOWEI BROMLEY, 1924

This species was long known only from MA and from the Susquehanna River in PA and NY. In 1979, KENNEDY & WHITE described the larva and recorded populations from New River, VA. CARLE (1981) summarized state distributions as: KY, MA, NY, NC, PA, VA, and LOUTON (1982a) added Monroe Co., TN, stating that this may be the southern limit at a site unfortunately under the water of the Tellico Reservoir. Kennedy & White detailed the larval habitat, and from their information, from CARLE (1979a), and from Louton it is clear that the larvae are associated with sand and gravel in swiftly flowing, unpolluted and undammed rivers. Carle found the species endangered in VA. It seems to be **vulnerable**, likely to move into the endangered category in the near future because of the rapidly increasing scarcity of large, undisturbed, swiftly flowing rivers in eastern US.

OPHIOGOMPHUS INCURVATUS CARLE, 1982

In 1979 a, CARLE listed O. carolinus Hagen as rare, but in 1982 he showed that the name is invalid. He stated that the type larva which Hagen described is actually O. rupinsulensis Walsh, and thus adults referred to by various authors (e.g. NEEDHAM & WESTFALL, 1955) as O. carolinus should have a new name, O. incurvatus Carle. This species separates into two subspecies: O. i. incurvatus on the eastern side of the Appalachian Mountains in MD, VA, NC, SC, GA, and O. i. alleghaniensis Carle on the western side in WV, VA, TN, AL. CARLE (1982) thought the species rare because of the larval habitat: riffle areas of spring fed streams where gravel overlies soft mud in shallow water. A category of rare seems to be an appropriate Red Book listing.

PROGOMPHUS BELLEI KNOPF & TENNESSEN, 1980

It is recorded from Calhoun, Gulf, Leon, Liberty, Santa Rosa, and Wakulla Cos. in the FL Panhandle (DUNKLE & WESTFALL, 1982; KNOPF & TENNESSEN, 1980); from nearby Henry Co., AL (BICK & BICK, 1983); and strangely, from the distant Bladen Co., NC (KNOPF & TENNESSEN, 1980).

The absence of GA and SC records suggests that determinations of *Progomphus* from these states should be reviewed carefully. The species is reported from small, sandy streams and sandy lakes and ponds (KNOPF & TENNESSEN, 1980). DUNKLE & WESTFALL (1982) found it **rare** in FL, and this seems to be an appropriate *Red Book* listing.

STYLURUS POTULENTUS (NEEDHAM, 1942)

This species was described (NEEDHAM, 1942) from 1 3 from Whisky Creek, Greene Co., MS. DUNKLE & WESTFALL (1982) recorded it from Calhoun, Okaloosa, and Santa Rosa Cos., FL, and there are specimens in FSCA from Jackson, Pearl River, and Perry Cos., MS. The scarcity of this species is evidenced by the fact that there are only four specimens in FSCA from the well studied FL Panhandle, and only one was collected in each of the following years: 1970, 1973, 1975, 1978. This species seems to be restricted to streams in a narrow Gulf Coastal strip from western FL to Southwestern MS. Much of this area is disturbed by stream pollution and channelization. Cook (pers. comm.) considered the species rare, and DUNKLE & WESTFALL (1982) found it threatened in FL. Because environmental pressure within the very limited range will probably increase in the near future, the species should be considered vulnerable.

STYLURUS TOWNESI (GLOYD, 1936)

It is reported from: Greenville Co., SC (GLOYD, 1936); Escambia Co., AL (TENNESSEN, 1979); Okaloosa, Santa Rosa Cos., FL (DUNKLE & WESTFALL, 1982). There are also specimens in FSCA from Columbus Co., NC and from George, Jackson, Pearl River Cos., MS. All collections have been from streams. The type \mathcal{F} was taken on the Saluda River, SC, a few miles below the reservoir at Table Rock Mountain (GLOYD, 1936); a Q was collected from the Conecuh River, AL (TENNESSEN, 1979); and DUNKLE & WESTFALL (1982) found larvae burrowing in sand in the Blackwater River system, FL. In FL the species is considered threatened (DUNKLE & WESTFALL, 1982), and both C. Cook and D.R. Paulson (pers. comm.) thought it rare. Although this riverine species faces the possibility of increased habitat modification by damming, a classification of rare is appropriate in the absence of a specific threat.

Aeshnidae AESHNA PERSEPHONE DONNELLY, 1961

The only published record (DONNELLY, 1961) is from AZ in the Chiricahua Mountains, Cochise Co., and from Oak Creek Canyon, Coconino Co. R.W.

Garrison (pers. comm.) stated that he has a \Im from Yavapai Co., AZ, that there is 1 \Im at Northern Arizona University from the same Co., and that there is a \Im from Coconino Co. in the Grand Canyon National Park collection. Donnelly found this species at a mountain stream lighted by the sun for only a few hours each day, and S.W. Dunkle & and R.W. Garrison (pers. comm.) found it at a wooded canyon stream and at a small pond. Hopeful that the Chiricahua National Monument and the Coconino National Forest will provide some measure of protection, I propose a category of **rare**.

Cordulegastridae CORDULEGASTER SAYI SELYS, 1854

It was described from GA, and there is one specimen in the Academy of Natural Sciences Philadelphia from Thomas Co., GA collected in 1904. Other than this locality, the species is limited to FL. DUNKLE & WESTFALL (1982) summarized its FL distribution where it is known from only seven localities: Lake City, Columbia Co.; Gold Head Branch State Park, Clay Co.; Torreya State Park, Liberty Co.; San Felasco State Preserve, Alachua Co.; Blackwater River State Forest, Santa Rosa Co.; the city of Gainesville, Alachua Co.; one indefinite location. Dunkle & Westfall stated that the species has very precise habitat requirements: silt-bottomed spring seepages in hardwood forest with weedy clearings nearby for foraging and mating. The largest and perhaps the only viable population is in a rapidly expanding section of the city of Gainesville where the species is acutely threatened by a housing development. Here, only 0.8-1.2 ha remain intact, and extinction seems imminent. The salvation of the species is in State areas which should provide some protection if viable populations are still present there. Dunkle & Westfall considered the species threatened in FL. A Red Book listing of endangered is clearly indicated.

Macromiidae MACROMIA MARGARITA WESTFALL, 1947

It is recorded from Little River, Transylvania Co., NC (WESTFALL, 1947); Lumpkin Co., north GA (KORMONDY, 1960); Pickens Co., northwestern SC (WHITE et al., 1980). There are specimens in FSCA from Macon Co., NC and Floyd Co., VA. Although the species occurs in four states, all localities are in a small area of the Appalachian Mts. C. Cook (pers. comm.) found the species rare, and CARLE (1979a) thought that it was endangered. Because there seems to be no specific threat and because there are protected areas within its distribution, a category of **rare** is suggested.

MACROMIA WABASHENSIS WILLIAMSON, 1909

This species was described from 10 \Im from Wabash River, Wells Co., IN (WILLIAMSON, 1909). Since then only five specimens have been recorded: PRICE (1958) listed two from Paulding Co., northwestern OH; MONT-GOMERY (1971) reported one from Wayne Co., eastern IN; WILLIAMS (1982) recorded two from McLennan Co., TX. There are also 2 \Im in FSCA collected by Price from Defiance Co., OH. Price stated that his specimens may be immatures of *M. taeniolata* Rambur, D.R. Paulson (pers. comm.) questioned the validity of *M. wabashensis*, and Williams stated that its status seems to be uncertain. C. Cook (pers. comm.) considered the species endangered, but because it may be a synonym or variant of *M. taeniolata*, a listing of **insufficiently known** is indicated.

Corduliidae SOMATOCHLORA BREVICINCTA ROBERT, 1954

The species is known only from the type series collected from two stations in cold northern bogs near the southern end of Lake Mistassini, Quebec (ROBERT,1954). ROBERT (1963), WALKER & CORBET (1975), and HUTCHINSON & LAROCHELLE (1977) all repeat only the original data. After more than 28 years, the species is known only from the original stations in Quebec. Since these sites, at approximately 50° N latitude are beyond heavily settled areas where there seems to be no immediate threat, a *Red Book* category of **rare** is proposed.

SOMATOCHLORA CALVERTI WILLIAMSON & GLOYD, 1933

This species is known only from five FL Panhandle Cos. and from one in southeastern SC. DUNKLE & WESTFALL (1982) listed it from Gadsden, Franklin, Liberty, Leon Cos., FL, and S.W. Dunkle (pers. comm.) collected it in Okaloosa Co., FL. WHITE et al. (1980) recorded it from Allendale Co., SC. Scarcely anything on habitat has been recorded other than WILLIAMSON & GLOYD's (1933) collection of adults a little less than 1 km away from a stream. Although numerous adults were collected in 1971 from Torreya State Park, Liberty Co., FL (FSCA), the species is known elsewhere from very few individuals. NEEDHAM & WESTFALL (1955) and C. Cook (pers. comm.) considered the species rare. Because the Torreya State Park and the recently acquired Nature Conservancy area along the Apalachicola River should provide some measure of protection, a category of **rare** is indicated.

SOMATOCHLORA HINEANA WILLIAMSON, 1931

It was described from Logan Co., OH, and no additional OH specimens were reported until PRICE (1958) recorded it from Lucas and Williams Cos., OH, not far from Williamson's original site. MONTGOMERY (1953) recorded it from Gary, Lake Co., IN. The total number of individuals ever collected seems to be only 29, none of which was taken in the last 24 years. WILLIAMSON (1931) recorded the species along a dredged channel of a small stream in heavy swamp woods, but all of PRICE's (1958) collections were from bogs. S. hineana is almost certainly extinct in the Gary, IN, area where there is heavy pollution from steel mills and associated industry. Indeed, because only one individual was collected there, it is doubtful if a viable population was ever present. Relative to the three populations from northwestern OH, the species has not been collected from Logan Co. since 1930 in spite of intensive collecting by Price, and it is probably no longer present there. Since only 1 &, 1 Q were ever collected from Williams Co., OH, any population still present there must be very small. The largest number of specimens collected was from the Oak Openings State Preserve (19 adults) in Lucas Co., OH, at the western end of Lake Erie, near the heavily industrialized Toledo area where its continued presence must be considered problematical. F.L. Carle and D.R. Paulson (pers. comm.) considered the species endangered, and this is an appropriate Red Book listing.

SOMATOCHLORA INCURVATA WALKER, 1918

This species is recorded from widely separated localities in northeastern North America. It is reported from: Nova Scotia; Parry Sound and Nipissing, Ont.; Chippewa Co., MI; Clinton Co., PA; Hancock Co., ME (SHIFFER, 1969; WALKER, 1918; WALKER & CORBET, 1975; WHITE, 1969). The species has been taken from a quiet, fair-sized, forest stream (Nipissing), from a sphagnumchoked pool (Acadia National Park), and from a tamarack bog in PA (SHIFFER, 1969; WALKER & CORBET, 1975). It seems appropriate to consider this seldom collected species **rare**.

SOMATOCHLORA MARGARITA DONNELLY, 1962

It is known only from the Sam Houston National Forest, San Jacinto Co., southeastern TX (DONNELLY, 1962, 1978). The type series was collected from low, gently rolling country where the streams were clear, sandy and not conspicuously colored by tannin. The Sam Houston National Forest should protect this very localized and scarce species. In the absence of any specific threat, a category of **rare** is suggested.

SOMATOCHLORA OZARKENSIS BIRD, 1933

It is recorded from: Latimer Co., OK (BIRD, 1933); Leflore Co., OK (PRITCHARD, 1936); Franklin, Washington Cos., AR (HARP & RICKETT, 1977; HOUSTON, 1970); Woodson Co., KS (HUGGINS, 1978); MO (NEEDHAM & WESTFALL, 1955). Bird gave detailed habitat notes for the type series collected from the upper portion of Cunneotubby Creek which had frequent rapids over rounded sandstone boulders and was bordered by a fringe of willows. Pritchard collected adults as they flew near Fourche Moline Creek. In contrast with these creek collections, Houston found one specimen at a stock pond. C. Cook (pers. comm.) considered the species **rare**, an appropriate *Red Book* listing.

WILLIAMSONIA LINTNERI (HAGEN, 1878)

It seems to be restricted to a small coastal area in northeastern US from NH to NJ where it has been collected from: Strafford Co., NH (WHITE & MORSE, 1973); Albany Co., NY and Passaic Co., NJ (DAVIS, 1913); Norfolk, Middlesex Cos., MA (FSCA); RI (NEEDHAM & WESTFALL, 1955). This rare spring dragonfly of sphagnum bogs was long overlooked because of its early flight season (WHITE & RAFF, 1970; WHITE & MORSE, 1973). The latter authors, along with C. Cook (pers. comm.), considered the species rare. Because *W. lintneri* occurs in bogs and mostly in heavily populated areas of the US, a category of vulnerable is proposed.

Libellulidae LIBELLULA JESSEANA WILLIAMSON, 1922

This purple-bodied *Libellula* is reliably reported only from FL where it is very local (DUNKLE & WESTFALL, 1982). They stated that as yet it has not been determined whether this is a distinct species or a color variety of the common *L. auripennis* Burmeister. If *L. jesseana* is a valid species, it is indeed rare. However, because of its doubtful taxonomic status it must be considered **insufficiently known**.

DISCUSSION

In the US and Canada there are approximately 425 odonate species, and I consider 32 to be at risk. If these numbers are correct, 7.8% of the fauna is at risk. Further study will probably remove some species from the list and add others. Thus the proportion will remain conservatively at about 8%, a much lower figure than CARLE's (1979a) 20% for VA, the JOINT COMMITTEE CONSERVA-

TION OF BRITISH INSECTS (1973) estimate of 28%, and SCHMIDT's (1977) impressive proportion of 61% for the German Federal Republic.

The 32 species at risk fall into the following *Red Book* categories: rare (62%), vulnerable (16%), endangered (9%), insufficiently known (9%), probably extinct (3%) (Tab. I). Extinction threatens the three species listed as endangered, and one of these, *S. hineana*, may already be extinct. A search should be conducted very soon in IN and OH to determine if any populations of *S. hineana* survive, and if so to pinpoint their locations and to carry out biological studies. Also, a search for additional populations of *C. sayi* in north FL and biological studies should be conducted. Such studies should bring knowledge of these two species to par with that of *I. gemina*, well studied by GARRISON & HAFERNIK (1981a, 1981b). Effort must be made to find some means of protecting the few surviving populations of *I. gemina*.

Among the 11 families in US and Canada, no species is at risk in Petaluridae, Calopterygidae, Lestidae. The number of threatened species by family is: Gomphidae-17, Corduliidae-7, Macromiidae-2, Coenagrionidae-2, and one each in Aeshnidae, Cordulegastridae, Libellulidae, Protoneuridae. The family Gomphidae makes up approximately 22% of the fauna of the US and Canada but constitutes 53% of the species at risk. So the large number of threatened gomphines is not merely a function of group size. I think that a primary reason for the large number of threatened gomphines is that they are mostly stream inhabitants (WALKER, 1958), a habitat that has been drastically modified.

Among the 32 threatened species, 82% are associated with flowing water. CARLE (1979a) found that 75% of the rare species in VA inhabit lotic waters, and nearly all species which DUNKLE & WESTFALL (1982) considered rare in FL are those of lotic habitats. In contrast, the monotypic genera of the US and Canada are primarily inhabitants of lentic water and none is threatened. The loss of clear, high-quality, undammed, and entirely undisturbed streams, especially larger ones, is the most significant factor placing odonate species on the threatened list. GARRISON (1981b; pers. comm.) suggested that the dispersal potential of even the small *I. gemina*, an inhabitant of lentic areas, may increase its chances of survival when small demes are threatened with destruction. This dispersal potential operates more widely among lentic than among lotic species (LOUTON, 1982a) and thus seems to be a reason why the former is so much less threatened.

In an effort to locate significant areas for conservation, an attempt was made to find reasonably small areas wherein more than one threatened and narrow endemic species is present. Candidates for endemism are species limited to only one state or province. The eight so-limited species are: *A. persephone* (AZ), *O. acuminatus* (TN), *O. edmundo* (NC), *S. brevicincta* (Que.), *S. margarita* (TX), *L. jesseana* (FL), *N. aaroni* (TX), *I. gemina* (CA). *S. margarita* and *N. aaroni* are both in TX, but they are separated by approximately 200 km. There seems to be

 Table I

 Summary of status and distribution of species at risk in the United States and Canada

Status	Distribution
ENDANGERED	
Ischnura gemina	CA
Cordulegaster savi	FL, GA
Somatochlora hineana	IN, OH
VULNERABLE	
Enallagma recurvatum	MA, NJ, NY
Ophiogomphus anomalus	Que., Ont., ME, NY, WI
O. howei	KY, MA, NC, NY, PA, TN, VA
Stylurus potulentus	FL, MS
Williamsonia lintneri	MA, NH, NJ, NY, RI
RARE	
Neoneura aaroni	тх
Gomphus (Gomphurus) consanguis	AL, GA, TN, VA
G. (Gomphurus) ozarkensis	AR, OK
G. (Gomphurus) septima	AL, NC
G. (Gomphus) diminutus	FL, NC, SC, TN
G. (Gomphus) hodgesi	AL, FL, LA, MS
G. (Hylogomphus) geminatus	AL, FL, GA
G. (Hylogomphus) parvidens	AL, GA, MD, NC, VA
Ophiogomphus acuminatus	TN
O. arizonicus	AZ, NM
O. incurvatus	AL, GA, MD, NC, SC, TN, VA, WV
Progomphus bellei	AL, FL, NC
Stylurus townesi	AL, FL, MS, NC, SC
Aeshna persephone	AZ
Macromia margarita	GA, NC, SC, VA
Somatochlora brevicincta	Que.
S. calverti	FL, SC
S. incurvata	N.S., Ont., ME, MI, PA
S. margarita	тх
S. ozarkensis	AR, KS, MO, OK
INSUFFICIENTLY KNOWN	
Gomphus (Hylogomphus) carolinus	NC, SC
Macromia wabashensis	IN, OH, TX
Libellula jesseana	FL
PROBABLY EXTINCT	
Ophiogomphus edmundo	NC

no one small area where conservation efforts could be marshalled for the simultaneous protection of more than one narrow endemic.

The geographic distributions of the threatened species were considered more generally. None occur in western Canada, in northwestern US, or in the Northern Great Plains. The threatened species are in three eastern Canadian provinces and in 31 states, more than half of which are east of the Mississippi River. The number of species at risk is particularly high in southeastern US, and the states with the greatest number of species (Tab. I) are all in this area. They are: NC (10), FL (9), AL (8). In the southeast are two areas with a fascinating array of threatened odonates, a diversity which correlates with the diversity of all species in the area. These areas and the threatened species whose main ranges are located therein are as follows:

- The southeastern highlands from northeastern AL to southwestern VA including parts of the Piedmont, Blue Ridge, Valley & Ridge and Cumberland Plateau Provinces of FENNEMAN (1938). G. consanguis, G. septima, G. parvidens, O. incurvata, M. margarita.
 - A narrow strip along the Gulf Coast from southeastern LA to the eastern part of the FL Panhandle. G. geminatus, G. hodgesi, P. bellei, S. potulentus, S. calverti.

These two areas must be considered important in conservation efforts directed to the rare, if not endangered, odonates of North America.

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