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Odonata in Trentino (NE-Italy): historical and recent data

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SUMMARY - *Odonata in Trentino (NE-Italy): historical and recent data* - The historical presence of Odonata in Trentino was reconstructed using data from the collections of the Natural Science Museum of Trento and from existing literature. Recent (2006-2007) observations by the authors in selected biotopes were conducted to start an updated list of species for the Trento Province. Odonata are one of the most interesting invertebrate taxa due to their ecological and trophic features, which allow their use as good and useful indicators of the ecological quality of freshwater biotopes and their neighbouring areas, and of the impact of human activities. The updated database (1699 records) comprises 64 species (77% of the Italian species). Large part of the records regarded lowland areas, but altitudinal preferences in some Odonata species was evident. The database comprises common and widespread species, as *Aeshna juncea*, *A. cyanea*, *Platycnemis pennipes*, *Ischnura elegans*, *Sympetrum striolatum* and *Coenagrion puella*. Rare species were represented by *Epitheca bimaculata*, *C. ornatum, Sympecma paedisca*, *Leucorrhinia pectoralis*, *Ophiogomphus cecilia*, *Somatochlora flavomaculata*, *Sympetrum depressiusculum*. Some of these were recorded before the 50's only in floodplain wetlands of the Adige Valley, which were claimed in the second half of last century, thus causing a local extinction. Recent and spatially limited observations allowed recording the presence of 24 species.

RIASSUNTO - *Odonati in Trentino (NE Italia): dati storici e recenti* - La presenza storica di Odonati in Trentino è stata ricostruita utilizzando dati provenienti dalla collezione del Museo Tridentino di Scienze Naturali e dalla letteratura esistente. La raccolta di dati da parte degli autori negli ultimi anni (2006-2007) in biotopi selezionati ha permesso di stilare la lista aggiornata delle specie di Odonati presenti in Trentino. Per le loro caratteristiche ecologiche e trofiche, che li rendono utili indicatori della qualità degli ambienti di acque dolci e degli ecotoni limitrofi, gli Odonati sono uno dei più interessanti taxa di invertebrati anfibiotici. Il database aggiornato (1699 record) comprende 64 specie, (77% di quelle appartenenti alla fauna italiana). La maggior parte dei record proviene da aree di bassa quota, ma sono piuttosto evidenti in alcune specie preferenze altitudinali. Il database include specie comuni e largamente diffuse come *Aeshna juncea*, *A. cyanea*, *Platycnemis pennipes*, *Ischnura elegans*, *Sympetrum striolatum* e *Coenagrion puella* e specie rare come *Epitheca bimaculata*, *C. ornatum*, *Sympecma paedisca, Leucorrhinia pectoralis*, *Ophiogomphus cecilia*, *Somatochlora flavomaculata*, *Sympetrum depressiusculum*. Alcune di queste specie sono state segnalate solo prima degli anni '50 e limitatamente alle zone umide della Val d'Adige, che sono state bonificate nella seconda metà del secolo scorso, causando così alcune estinzioni a livello locale. I record recenti, limitati ad alcune aree, hanno consentito di confermare la presenza di 24 specie.

Parole chiave: Odonati, dati storici, insetti acquatici, Trentino, Alpi
Key words: Odonata, historical presence, aquatic insects, Trentino, Alps

1. INTRODUCTION

According to Ruffo & Stoch 2005, the Italian odonatofauna comprises 89 species (32 Zygoptera, 57 Anisoptera), belonging to 9 families with 36 genera and representing 78% of the 114 European species (Askew 2004).

Adult dragonflies (Anisoptera) and damselflies (Zygoptera) are one of the most easily recognizable insect taxa, due to their large size, bright colours and behaviour. There are 5680 described species worldwide (Kalkman *et al.* 2008) which have a rare feature among Hexapoda: they are generalized predators through all their life cycle, during both larval and adult stages. One of the reasons for their evolutionary success is their unique flying skill, equalled only by some Diptera, due to special features of their wings. Large dragonflies may achieve speed up to 25-30 kilometres per hour. Flight ability couples with a well developed vision. The large compound eyes enable them to discriminate forms

and colours in a panoramic view with a range of several meters. (Askew 2004).

Their life cycle depends on the suitability of both aquatic and terrestrial habitats and of abundant and diversified preys. Furthermore, the composition of microhabitats (e.g. mud, submerged vegetation, algal mats) is important for many species. The adults too have specific preferences regarding favourite hunting or resting spots, as reed beds, riparian scrubs or willows, ash trees etc. So diversity of the local odonatofauna is a good indicator of the overall ecological quality of water bodies and related land-water ecotones (Chovanec & Waringer 2001; Schindler *et al*. 2003; Chovanec *et al*. 2004; Smith *et al.* 2006). It has been suggested that an abundant and diversified dragonfly community implies a healthy and stable ecosystem, due to their strong relationship with the structure and ecological integrity of their habitats (Chovanec 1994; Steytler & Samways 1995; Sahlén & Ekestubbe 2001; Hawking & New 2002). The use of dragonflies as bio-indicators offers several advantages: they are widespread and represent one of the historically most studied insect groups, so there is a good knowledge of the ecological requirements of a large number of species and of their distribution and seasonality; they are relatively easy to observe and identify, and finally they are well dependent from the ecological conditions of the environment. Some species are so specialized that they select a particular part of a plant: for example *Coenagrion pulchellum* often oviposits in the under surface of water-lily leaves (Askew 2004), while the life-cycle of other species depends on the presence of different plant alliances or associations (Buchwald 1994). So the reduction of riparian habitats due to human activities (Müller *et al.* 2003; Lee Foote & Rice Hornung 2005) can reduce the number of dragonfly species and their abundance. Compared to dragonflies, damselflies species are adapted to a larger variety of conditions, underlying the greater ecological diversity of this taxon (Samways & Steytler 1995). Another advantage of using dragonflies as bio-indicators is the relatively small number of species, most of which can be identified in the field or by examining last larval exuviae, thus meeting requirements of conservation strategies. Resident species can be easily identified by collecting exuviae or larvae or by observing the adult breeding behaviour. Their long life cycle also allows to use them for medium and long-term monitoring (Chovanec & Waringer 2001; Chovanec *et al.* 2004). Human activities have a great influence on dragonflies, that can quickly react by appearing or disappearing, thanks to their great displacement power that enables them to rapidly colonize new habitats. In about a hundred species true migration behaviour has been observed (Prandel 2001; Artiss 2004; Wikelski *et al*. 2006). Finally, due to their predator behaviour, they can also be useful as heavy metal pollution indicators (Nummelin *et al.* 2007).

The status of the Italian odonatofauna is well-known thanks to the Checklist of the Species of the Italian Fauna (last update 2004) and to some regional studies (Carchini *et al.* 2005; Boano *et al.* 2007). In Trentino there is a lack of knowledge, because the most recent records dated back to1987 (Casellato & Zanfei 1988) and most part of data refers to the first half of the last century. Only recently local research has focused again on this taxon (Maiolini *et al.* 2006) and will hopefully continue.

2. STUDY AREA

The study area is the Trento Province, in north-eastern Italy, an Alpine region with a surface of 6206 km^2 included between 10° 30′ and 11° 50′ East longitude, 45° 40′ and 46° 30′ North latitude.

It is mostly a mountain region, with the lowest elevation at Lake Garda (65 m a.s.l.) and the highest at Cevedale Peak (3764 m a.s.l.). Remnants of the last glaciation are about 300 lakes, mostly small high elevation Alpine lakes (Tomasi 2004). The major lowland lakes are Garda, Caldonazzo and Levico. Most historical records refer to wetlands formerly extended in the Adige Valley, to the Upper Valsugana (Caldonazzo and Levico lakes) and to wetlands in the Fiemme Valley. The records refer to 118 different localities distributed in the Trentino. Number of observations and of recorded species are summarized in figure 1, using a IGM 1970 grid with 47 quadrants.

3. METHODS

The data were collected starting from the Odonata collection of the Natural Science Museum of Trento (MTSN). The first sample (*Sympetrum striolatum*, Lavarone) was collected by Galvagni in 1921, while the last in 1952. Most species were identified by Cesare Conci and Osvaldo Galvagni. Other records derive from literature (Ausserer 1869; Conci & Galvagni 1944, 1946; Bucciarelli 1972; Mascagni & Terzani 1983; Casellato & Zanfei 1988) and from the Italian Checklist. Finally, recent records are dated 2006-2007, collected by the authors using a pond net for larvae and field observations for the adults. Thus a 20-years gap in the knowledge of distribution of Odonata in Trentino exists between the end of the eighties and 2006.

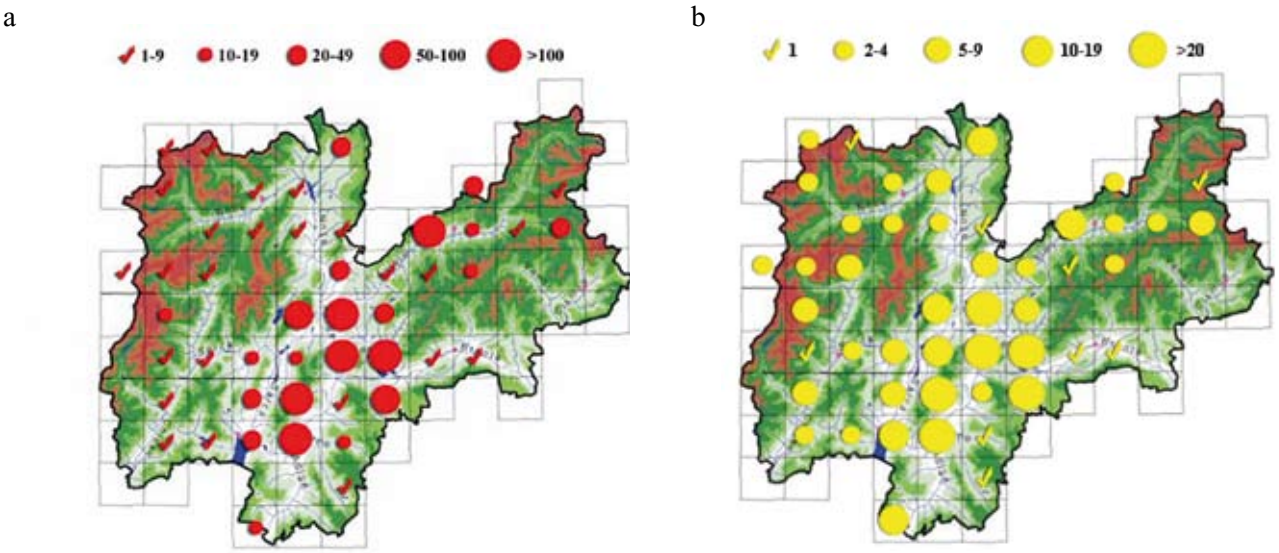

Fig. 1 - a. Number of records divided in five classes (1-9, 10-19, 20-49, 50-100, >100); b. number of species divided in five abundance classes (1, 2-4, 5-9, 10-19, >20).
Fig. 1 - a. Numero di record divisi in cinque classi (1-9, 10-19, 20-49, 50-100, >100); b. numero di specie divise in cinque classi di abbondanza (1, 2-4, 5-9, 10-19, >20).

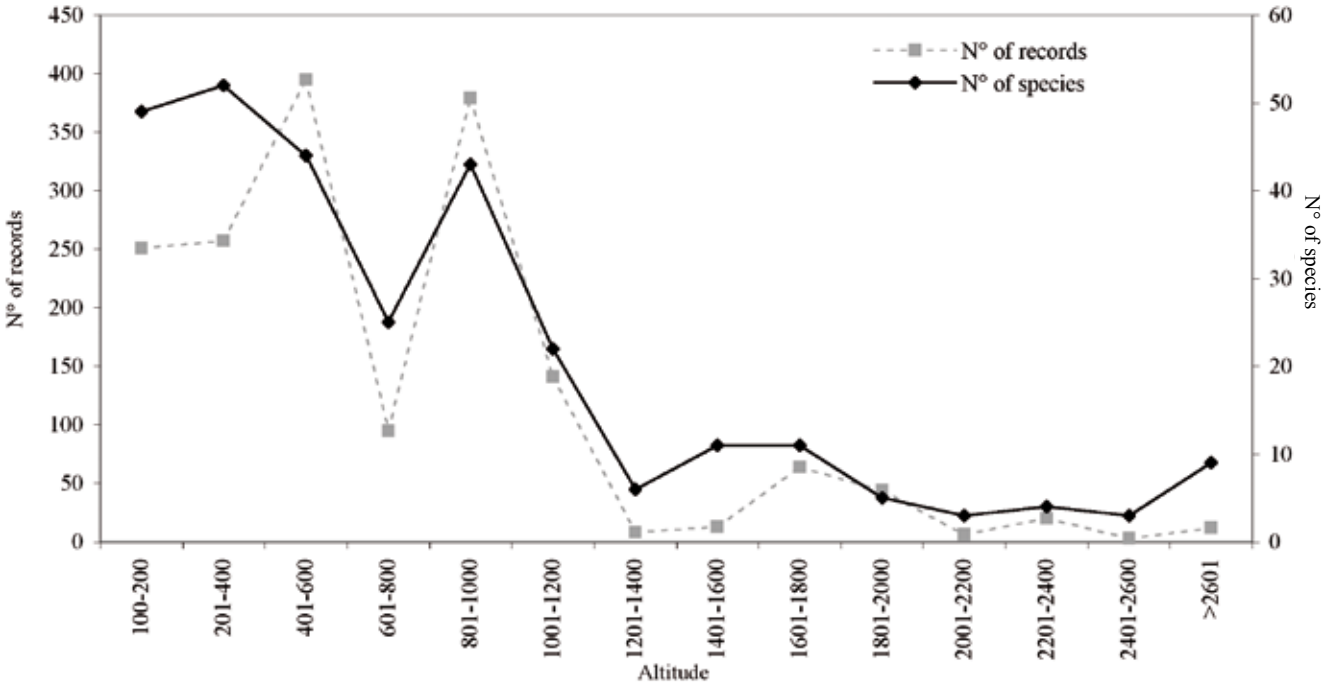

Fig. 2 - Number of records (black line, left ordinate axis) and number of species (grey dotted line, right ordinate axis) according to altitude.
Fig. 2 - Numero di record (linea nera, asse delle ordinate sinistro) e numero di specie (linea grigia punteggiata, asse delle ordinate destro) in base all'altitudine.

To understand altitudinal distribution, we choose to compare species using altitudinal classes of 100 meters extension each. The different spots were aggregated in these classes, according to their altitude, calculated with on-line GIS and topographic maps. Figure 2 highlights a decreasing number of species with increasing altitude.

4. RESULTS

The historical presence of 64 species belonging to 28 different genera was assessed. The total number of records was 1699, with 667 coming from the collection of MTSN, 915 from literature and the Italian Checklist and 117 from 2006-2007 observations (Tab. 1).

Tab. 1 - List of Trentino species, divided in historical presence (literature data and collection of the Museo Tridentino di Scienze Naturali) and recent presence.
Tab. 1 - Lista delle specie trentine, divisa in presenze storiche (letteratura e collezioni del Museo Tridentino di Scienze Naturali) e presenze recenti.

Species	Historical	Recent
Aeshna affinis (Vander Linden, 1820)	5	
Aeshna caerulea (Stroem, 1783)	10	
Aeshna cyanea (Müller, 1764)	68	4
Aeshna grandis (Linnaeus, 1758)	13	
Aeshna isosceles (Müller, 1767)	1	
Aeshna juncea (Linnaeus, 1758)	90	
Aeshna mixta (Latreille, 1805)	15	5
Anax imperator (Leach, 1815)	17	4
Anax parthenope (Selys, 1839)	5	
Brachytron pratense (Müller, 1764)	2	
Calopteryx splendens (Harris, 1782)	31	6
Calopteryx virgo (Linnaeus, 1758)	29	1
Cercion lindenii (Selys, 1840)	7	2
Ceriagrion tenellum (de Villers, 1789)	2	
Chalcolestes (Lestes) *viridis* (Vander Linden, 1825)	23	3
Coenagrion hastulatum (Charpentier, 1825)	15	
Coenagrion ornatum (Selys, 1850)	3	
Coenagrion puella (Linnaeus, 1758)	50	20
Coenagrion pulchellum (Vander Linden, 1825)	10	
Coenagrion scitulum (Rambur, 1842)	14	
Cordulegaster bidentata (Selys, 1843)	6	
Cordulegaster boltonii (Donovan, 1807)	8	
Cordulia aenea (Linnaeus, 1758)	11	1
Crocothemis erythraea (Brullè, 1832)	10	
Enallagma cyathigerum (Charpentier, 1840)	49	10
Epitheca bimaculata (Charpentier, 1825)	6	
Erythromma najas (Hansemann, 1823)	47	
Erythromma viridulum (Charpentier, 1840)	8	
Gomphus vulgatissimus (Linnaeus, 1758)	3	
Hemianax ephippiger (Burmeister, 1839)	5	
Ischnura elegans (Vander Linden, 1820)	94	20
Ischnura pumilio (Charpentier, 1825)	12	
Lestes barbarus (Fabricius, 1798)	13	
Lestes dryas (Kirby, 1890)	38	1
Lestes sponsa (Hansemann, 1823)	90	
Lestes virens (Charpentier, 1825)	14	
Leucorrhinia pectoralis (Charpentier, 1825)	2	
Libellula depressa (Linnaeus, 1758)	16	1
Libellula fulva (Müller, 1764)	7	4
Libellula quadrimaculata (Linnaeus, 1758)	32	
Onychogomphus forcipatus (Linnaeus, 1758)	15	
Onychogomphus uncatus (Charpentier, 1840)	1	
Ophiogomphus cecilia (Fourcroy, 1785)	17	
Orthetrum albistylum (Selys, 1848)	4	
Orthetrum brunneum (Fonscolombe, 1837)	9	

(Tab. 1 - continued)
(Tab. 1 - continua)

Species	Historical	Recent
Orthetrum cancellatum (Linnaeus, 1758)	20	4
Orthetrum coerulescens (Fabricius, 1798)	17	3
Platycnemis pennipes (Pallas, 1771)	68	6
Pyrrhosoma nymphula (Sulzer, 1776)	7	4
Somatochlora alpestris (Selys, 1840)	17	1
Somatochlora arctica (Zetterstedt, 1840)	4	
Somatochlora flavomaculata (Vander Linden, 1825)	28	
Somatochlora metallica (Vander Linden, 1825)	39	
Sympecma fusca (Vander Linden, 1820)	19	
Sympecma paedisca (Brauer, 1882)	45	
Sympetrum danae (Sulzer, 1776)	79	
Sympetrum depressiusculum (Selys, 1841)	18	2
Sympetrum flaveolum (Linnaeus, 1758)	65	
Sympetrum fonscolombei (Selys, 1840)	11	1
Sympetrum meridionale (Selys, 1841)	7	
Sympetrum pedemontanum (Allioni, 1766)	47	2
Sympetrum sanguineum (Müller, 1764)	63	2
Sympetrum striolatum (Charpentier, 1840)	47	10
Sympetrum vulgatum (Linnaeus, 1758)	54	

Most records refer to the Val d'Adige area, followed by Castello di Fiemme, Caldonazzo and Levico lakes. This distribution is probably due to the different sampling effort of the few researchers that worked in Trentino, and to the presence of the largest wetland areas. More than 80% of the individuals were collected between 65 and 1000 m a.s.l., possibly due to the difficulties of Odonata in finding optimal habitats at high altitude, particularly true for the Mediterranean species, for which Trentino frequently represents the northern limit of their distribution area .

In all, 118 different locations with presence of Odonata were found in Trentino,

Figure 1 shows the study area divided in forty-seven 25x25 km squares, using the IGM25V reticulum; in figure 1a the number of records for each square, represented by five abundance classes and in figure 1b the number of recorded species, again represented by five abundance classes.

The square with the highest number of observations refers to lakes Levico and Caldonazzo (343 records, 20% of observations). Several squares include only one record: Breguzzo, Cima Sternai, Dimaro, Mezzana, Passo di Valles, Pasubio and Valfloriana.

The squares with the highest number of records also have the highest diversity, except for Lake Garda and the nearby Lake Loppio (the latter does not exist any longer) where relatively few records were collected, which however belong to many different species. The list also comprises some threatened species, according to Utzeri & D'Antonio (2005) and to the Habitat Directive. 92/43/CEE: *Epitheca bimaculata*, *Coenagrion ornatum*, *Sympecma paedisca, Leucorrhinia pectoralis*, *Ophiogomphus cecilia*, *Somatochlora flavomaculata*, *Sympetrum depressiusculum.*

5. DISCUSSION

The most widespread species in Trentino resulted *Aeshna juncea*, recorded in 33 different locations, followed by *Aeshna cyanea*, present in 23 spots. These two *Aeshna* species are common in Europe, but *A. juncea* has a holartic distribution and is restricted to mountain regions in the southern limit of its range (Askew 2004), as is the case of Trentino. Other widespread species are *Platycnemis pennipes*, *Ischnura elegans*, *S. striolatum* and *C. puella*, all with pan-European ranges and considered as ubiquitous species (Conci & Nielsen 1956; Askew 2004).

The rarest species were *Aeshna isosceles*, *L. pectoralis*, *Onychogomphus uncatus*, *Brachytron pratense*,

Ceriagrion tenellum. *A. isosceles* has a Mediterranean distribution and it is typical of lowland lenthic biotopes (d'Aguilar *et al.* 1990). *L. pectoralis* is a Euro-Siberian species, present in Italy only with scattered colonies (Askew 2004). *O. uncatus* and *C. tenellum* are widespread in south-western Europe (Askew 2004; Dijkstra & Lewington 2006), while *B. pratense* is widespread in central Europe but rare in the southern Europe and known in Italy mainly form northern localities (Askew 2004).

As expected, the number of records was found well related with the number of species, with some exceptions as in the Castello di Fiemme spot, where 185 records referred to 12 species and the opposite condition was found in Monte Baldo where 17 records referred to 17 different species.

Several species were found with a good number of records but only in restricted spots of the study area: *Sympecma paedisca* (45 records in only 4 squares) and *Erythromma najas* (47 records in 3 squares). The first was found only in lowland marshes near Rovereto, the second (41 records) mostly around Lake Cei (1000 m a.s.l.). Both localities are in the southern part of the Adige Valley and almost all records refer to the period between 1929 and 1955.

The sampling was carried out with different intensities at different altitude, so a community statistical analysis was not possible, due to the consistent difference in number of records between low and high altitude classes. However, three species of the genus *Somatochlora* (*S. metallica*, *S. alpestris* and *S. arctica*) were recorded mostly above 1500 m a.s.l. These species have a central-northern European distribution and in their southern range are more probably found in mountain areas (Askew 2004). In particular, *S. alpestris* was recorded 18 times, 17 of which above 1500 m a.s.l. and it is the only species of the genus recorded in recent years (Lake Tovel, 2007). Other Anisopteran species found mostly above 1500 m a.s.l. are *A. careulea* (9 of 10 records above 1500 m a.s.l.) and *A. juncea* (only 6 of 90 records below 1000 m a.s.l. and other 25 between 1000 and 1500 m a.s.l.). Both have a northern European distribution and are restricted to mountain regions in the south (Askew 2004; Dijkstra & Lewington 2006).

In contrast, many other species were observed at most below 1500 m a.s.l. In particular, Zygoptera were extremely rare above 1500 m a.s.l., with 8 of 761 total records, and only 69 records between 1000 and 1500 m a.s.l. Anisoptera preferring lowland habitats belonged to the family Gomphidae, rare in the area but never found above 1000 m a.s.l., and the genus *Orthetrum*, recorded above 1000 m a.s.l. only in 4 of the 57 total records. Except for *O. coerulescens,* the only one recorded above 1500 m a.s.l., the other *Orthetrum* species prefer lowland ponds, lakes and slow flow streams (Askew 2004). Table 2 summarizes the number of records for each family, below and above 1500 m a.s.l.

At highest altitude, above 2600 m a.s.l. (between 2670 and 3703 m a.s.l.), we found 12 records, all collected between 1926 and 1939 and referred to 9 species. The most represented genus is *Sympetrum* with 8 records and six species. The other records were *A. juncea*, *C. erythraea* and the only Zygopteran *L. barbarus*, with two records coming from Presanella Peak. Each one of these records came from areas without suitable habitats, so erratic or migratory behavior or strong ascending currents were probably responsible of their presence in these areas.

Migratory behavior or displacement towards refuge areas are known for these species, especially for some *Sympetrum* species (*S. danae*). *S. striolatum* and *S. frequens*, the Japanese vicariant of the continental *S. depressiusculum*, move toward high altitude habitats (above 3000 m a.s.l.) for estivation during the pre-reproductive period (Corbet, 2004).

Frozen specimens of *Sympetrum* were found on snow and glacier ice around 3000 m in the Alps (Askew 2004).

The only Trentino specimens considered as migrant

Tab. 2 - Distribution of Odonata families below and above 1500 m a.s.l.
Tab. 2 - Distribuzione delle famiglie di Odonati sopra e sotto i 1500 m s.l.m.

Families	Below 1500	Above 1500
Calopterygidae	67	
Coenagrionidae	369	5
Lestidae	243	3
Platycnemidae	74	
Aeshnidae	158	86
Cordulegastridae	13	1
Corduliidae	66	41
Gomphidae	36	
Libellulidae	501	36
Total Zygoptera	753	8
Total Anisoptera	774	164
Total records	1527	172

are the species of the *Sympetrum* genus and *A. mixta* (Askew 2004; Corbet 2004). However, in 5 of the 9 species of *Sympetrum* and in *A. mixta*, reproductive and ovipositing behavior was observed by the authors. Thus, it was not possible to separate the migrant specimens from residential ones using historical data, also due to the lack of daily and monthly dates in most of historical records.

Among the species protected by the Habitats Directive, *S. paedisca* were the most abundant with 45 records (Conci & Galvagni 1944; Conci & Galvagni 1946). *O. Cecilia* had 18 records, the most coming from Levico Lake between 1869 and 1951. The other three species were present only with 11 records: three specimens of *C. ornatum*, two of *L. pectoralis* and six of *E. bimaculata. C. ornatum* was found only in 1869 and 1879, *L. pectoralis* only in 1946 and 1947, while the most recent report among these species was *E. bimaculata*, found in 1985. All these records came from the Adige Valley (Rovereto, Volano, Loppio Lake). However, due to the discontinuous and scattered sampling effort in the last 30 years, it is not possible to clearly describe the updated status of these species' population nowadays.

6. CONCLUSIONS

In Trentino we recorded the presence of 64 of the 83 Italian species and subspecies (Checklist 2004). The most part was collected below 1000 m a.s.l., thus confirming the important role of wetland habitats at low and medium elevation in the Alps, which are also the most menaced by human activities and infrastructures. Higher elevations limit plant communities, which are strongly linked with dragonflies abundance and species composition (Buchwald 1994; Askew 2004), but some species found suitable habitats and showed a clear preference for higher altitude zones. However, more observations are needed in these areas, as the few researchers that operated in Trentino concentrated their efforts in the lowlands. The wide distribution and the richness of Odonata in Trentino well allow the use of these insects to assess human and climate changes induced in freshwater ecosystems (Lee Foote & Rice Hornung 2005; Stone *et al*. 2005) and the efficiency of restoration measures by means of tools such as the Odonata Habitat Index (Chovanec & Waringer 2001). The building of this database is the first step to study the Odonata population of Trentino, a very interesting Alpine region, being the upper limit of Mediterranean species and the lower limit of North-European ones.

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