LONG TERM STUDY OF *HAEMATOBIA IRRITANS* (DIPTERA: MUSCIDAE) SEASONAL DISTRIBUTION IN CENTRAL ARGENTINA WITH FOCUS ON WINTER FLY ABUNDANCE

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Summary :

The seasonal distribution of *Haematobia irritans* (Linnaeus, 1758) was evaluated at 31° 12' S - 61° 29' W, Santa Fe, Argentina from November 1992 to August 2000 by weekly fly counts on 20 Holstein cows not treated against ectoparasites. The analysis was mainly focused on winter fly abundance. Two peaks of abundance were found from spring to autumn. Adults of *H. irritans* were consistently found on cattle during winter, with increasing numbers from the end of July to late August. The only climatic parameter soundly correlated with the four week period, before each winter fly count, was the mean air temperature with the exception of year 1998. No significant relationship was found between level of cow infestation and relative humidity, saturation deficit and rainfall. Horn fly infestation on cows was lower than 20 % from end of June to end of August only in 1995, when mean air temperature was consistently lower than 11°C during the four week period previous to most fly counts. Conversely, the mean temperature was higher than 12°C previous to fly counts in 1998, when most cows remained infested. The results indicate that a proportion (unknown) of immature stages of *H. irritans* were insensitive to diapause inducing factors and developed through winter.

KEY WORDS : *Haematobia irritans*, seasonal distribution, winter, Argentina.

MOTS CLÉS : *Haematobia irritans*, distribution saisonnière, hiver, Argentine.

Résumé : ÉTUDE DE LA DISTRIBUTION SAISONNIÈRE DE *HAEMATOBIA IRRITANS* (DIPTERA: MUSCIDAE) DANS LA RÉGION CENTRALE DE L'ARGENTINE, FOCALISÉE SUR L'ABONDANCE HIVERNALE DE LA MOUCHE

La distribution saisonnière de *Haematobia irritans* (Linnaeus, 1758) a été étudiée à Santa Fe, Argentine (31° 12' S - 61° 29' W), de novembre 1992 à août 2000, par le comptage hebdomadaire des mouches sur 20 vaches Holstein non traitées contre des ectoparasites. L'analyse a été focalisée principalement sur l'abondance hivernale de cette mouche. On trouve deux pics d'abondance du printemps à l'automne. En hiver on a trouvé des *H. irritans* adultes en permanence; leur nombre augmente de fin juillet à fin août. Le seul paramètre climatique véritablement corrélé à l'abondance pendant la période de quatre semaines précédant chaque décompte hivernal des mouches a été la température moyenne de l'air, à l'exception de l'année 1998. Aucune corrélation significative n'a été trouvée entre les niveaux d'infestation des vaches et l'humidité relative, le déficit de saturation et la pluviométrie. Le pourcentage de vaches infestées par la *H. irritans* entre fin juin et fin d'août a été inférieur à 20 % seulement en 1995, lorsque la température moyenne de l'air a été en permanence inférieure à 11°C pendant la période de quatre semaines préalable au décompte des mouches. Inversement, lorsque la température moyenne a été supérieure à 12°C préalablement au décompte des mouches en 1998, la majorité des vaches était infestée par *H. irritans*. Les résultats montrent qu'une proportion (inconnue) des stades immatures de *H. irritans* sont insensibles aux facteurs qui déclenchent la diapause et que leur développement se poursuit pendant l'hiver.

The horn fly, *Haematobia irritans* (Linnaeus, 1758) is a blood feeding parasite of cattle on pasture (Bruce, 1964) that was introduced from Europe to North America more than a century ago (Riley, 1889). It was first detected in Argentina at the end of 1991 (Luzuriaga *et al.*, 1991) where it rapidly colonized the area of importance for the cattle industry. Horn fly causes losses to cattle herds ranging from impair meat production (Haufe, 1987) to diminished leather quality (Guglielmone *et al.*, 1999). Its seasonal abundance is similar at approximately the same latitude in northern and southern hemispheres within

America (Kunz & Cunningham, 1977; Guglielmone *et al.*, 1997), comprising two peaks of abundance within the spring and the autumn.

Diapause is a pre-adaptive behaviour that forecast environmental conditions while, quiescence is a direct response to unfavourable climatic parameters such as heat or cold; quiescence is swiftly terminated when conditions become favourable (Beck, 1980). *H. irritans* can undergo diapause within the puparium as a response to temperature experienced by immature stages (Lysyk & Moon, 1994). Almost all horn flies from a Canadian laboratory strain cultured at temperatures below 16°C entered diapause (Lysyk, 1992). Even a low proportion of horn fly populations located between the Tropic of Capricorn and the Equator were found in diapause in Brazil during winter (Mendes & Linares, 1999). The *H. irritans* natural life cycle in sites north of 29° N in Texas is based on dia-

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pause to survive during winter (Wright, 1970; Kunz *et al.*, 1972; Kunz & Cunningham, 1977; Kunz & Miller, 1985; Thomas & Kunz, 1986). The overwinter strategy of *H. irritans* in South America at equivalent latitude of the studies previously mentioned is basically unknown. Eddi *et al.* (1993) found diapausing horn flies close to the Argentinian site used in this study. Nevertheless, diapause may not be the main overwinter mechanism in this relatively new colonized area, as a considerable proportion of cattle remain infested through winter time (Guglielmone *et al.*, 1997).

To know overwinter survival strategy of horn fly is not only relevant for its control (Kunz & Miller, 1985) but to understand the mechanisms to stand unfavourable climatic conditions. If *H. irritans* could combine diapausing and quiescent populations during winter, the ability to defeat control systems would be enhanced. We followed the seasonal distribution of horn fly during eight successive years at a site in central Argentina. The results are presented in this article, focusing on fly populations dynamics during winter.

MATERIALS AND METHODS

The study was carried out at the Instituto Nacional de Tecnología Agropecuaria, Estación Experimental Agropecuaria Rafaela (INTA Rafaela), Santa Fe, Argentina (31° 12' S - 61° 29' W) from the second week of November 1992 to the last week of August 2000. The study site has a continental climate characterised by a mean annual temperature of 18.9°C, ranging from 12.7°C in July to 26.0°C in January. The mean number of frost per year is 22.5 days and the mean annual rainfall is 935 mm, concentrated from October to April (Panigatti, 1980).

A herd of 25 to 45 dry Holstein cows never treated against ectoparasites, and maintained on lucerne paddocks through the above mentioned years was selected for the study. The population of *H. irritans* was measured weekly on 20 cows as presented elsewhere (Guglielmone *et al.*, 1997). Pearson's correlation coefficients (*r*) were obtained to detect association between the 13 weekly counts per year corresponding to June, July and August with climatic parameters for the four

Fig. 1. – Mean numbers of *Haematobia irritans* per week on untreated Holstein cows from year 1992 to year 2000 in Rafaela (31° 12' S - 61° 29' W), Argentina.

week period previous to each fly count, recorded at the Meteorological Station of INTA Rafaela. The deterministic coefficient (r^2) was obtained when r was of high statistical significance ($P < 0.01$) (Guglielmone *et al.*, 1997). The climatic parameters used for correlation were mean air temperature ($^{\circ}\text{C}$) and mean relative humidity (%) obtained at 1.5 m above ground level as well as mean saturation deficit (mm Hg) and total rainfall (mm) for the four week period previous to each fly count.

RESULTS

The evolution of fly numbers through the study is presented in figure 1. The mean fly numbers on cows varied greatly amongst years but sharing a bimodal peak of abundance. This was not particularly evident during the 1999-2000 fly season since the second peak of fly abundance was considerably lower than the first one.

The evolution of horn fly numbers on cows from June to August during the years 1993 to 2000 is depicted in figure 2 along with the mean air temperature for the four weeks previous to each count. The mean *H. irritans* number per cow at the first week of June ranged from 8.4 (1995) to 46.8 (1994), whilst these numbers on the last week of August ranged from 2.6 (1993) to

36.1 (1996). A tendency of declining *H. irritans* populations by the end of July was observed between those weeks with an increase of fly numbers throughout August. The percent of cows infested with *H. irritans* from June to August is presented in Table I. The only year where the percent of infestation was consequently lower than 20 %, from the end of June to the end of August was 1995. On the contrary, the lowest level of cow infestation was 50 % during 1998, when all cows remained infested in nine of the 13 winter weeks.

The only climatic parameter soundly correlated with the four week period before each winter fly counts was the mean temperature with the exception of the winter of 1998 ($r = 0.221$, $P > 0.05$). For other years the r ranged from 0.696 ($r^2 = 0.484$, $P < 0.01$, year 1993) to 0.878 ($r^2 = 0.771$, $P < 0.01$, year 1999).

The mean air temperature did not vary much (10.4 to 11.4°C) during the four week period previous to fly counts of week 5 to week 12 in 1995 winter when most cows remained free of *H. irritans*. Conversely, the mean temperature had a small variation (12.2 to 13.5°C) during the four week period before fly counts from week 4 to week 13 in 1998 winter, when most cows remained infested. Although the temperature variation was small, the horn fly populations on cows increased from week 6 to week 13, resulting in a lack of significant correlation between fly counts and temperature.

Fig. 2. – Mean numbers of *Haematobia irritans* on untreated Holstein cows from the first week of June to last week of August and mean air temperature (closed circles) during the four weeks period previous to each fly count from year 1993 to year 2000 in Rafaela ($31^{\circ} 12' \text{ S} - 61^{\circ} 29' \text{ W}$), Argentina.

Years Weeks	1993	1994	1995	1996	1997	1998	1999	2000
1	100	95	55	100	100	100	100	100
2	85	90	65	95	100	100	95	100
3	65	75	30	45	90	100	95	55
4	40	55	0	50	100	100	100	80
5	65	50	10	20	75	100	85	90
6	45	5	10	10	35	85	80	30
7	30	30	5	5	10	50	50	15
8	10	25	10	0	30	75	40	30
9	15	20	0	5	70	90	65	60
10	30	10	0	40	50	100	70	55
11	10	55	0	45	50	100	95	75
12	25	65	0	95	100	100	65	85
13	40	80	35	100	90	100	70	100

Table I. – Percentage of cows infested with *Haematobia irritans* during the 13 weeks period starting from the first week of June to the last week of August during years 1993 to 2000.

DISCUSSION

The yearly evolution of *H. irritans* showed the same tendency found in a previous study (Guglielmone *et al.*, 1997). An adverse effect on meat production is considered to occur when *H. irritans* population exceeds 230 flies per bovine (Haufe, 1987); losses in dairy cows can occur with infestations of about 100 flies (Guglielmone *et al.*, 2001). The first level of infestation was not surpassed (or surpassed during short periods of time) throughout the study with the exception of the fly season 1999-2000, while mean *H. irritans* infestations higher than 100 was common from October to May. Nevertheless, using economic threshold to treat cattle against horn flies is not a common practice in Argentina and probably elsewhere. The winter abundance of horn flies in central Argentina was directly bound to temperature. The analysis carried out using mean air temperature is merely an indication of the importance of temperature for horn fly development during winter at the study site since *H. irritans* immature stages develop from egg to pupae in cattle manure where temperature is different to the air temperature. Previous information obtained at the study site, showed that ground winter temperature in soils covered with vegetation had the lowest amplitude in comparison to soils with different or no coverage. Ground temperature in soil covered by pastures can have a mean maximum temperature 4°C lower than air temperature and a mean minimum temperature 3-4°C higher than the corresponding mean minimum environmental temperature (Panigatti *et al.*, 1983). Puparium of *H. irritans* are found from bottom of manure to 3.5 cm deep in the soil beneath the manure pat (Bruce, 1964). The temperature in manure pat-soil interface is higher than air temperature (Jones & Kunz, 1997) whilst the minimum and maximum temperature

in manure pats was found to have a lesser amplitude than air temperature in a study site close to 50° N from Canada (Lysyk, 1999).

The continuous presence of *H. irritans* on cows during winter (year 1995 excepted) indicates that part of the horn fly population developed continuously during this season in central Argentina. This may be a consequence of the exposure of *H. irritans* immature stages to temperatures higher than a minimum threshold for continuous development. This is not to say that diapause in immature horn fly stages is absent but rather that quiescent and diapausing populations may share the same environment during winter. Kunz *et al.* (1983) successfully delayed the spring rise horn fly population by controlling diapausing population with cattle treatment in late summer – early autumn. It would be of importance to test the treatment strategy applied by Kunz *et al.* (1983) under local conditions.

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