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Relocation of City Raccoons

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Abstract.--Twenty-four city raccoons were radio-collared and relocated 25-45 km north of the original capture site in Toronto, Ontario. Following release, extensive exploratory movements were noted with distances of 2-7 km being traversed per night. Home ranges for adult males ($\bar{x}$ = 39 km^2) and females ($\bar{x}$ = 72 km^2) far exceeded juvenile ranges and areas utilized by raccoons in an urban setting. None of the raccoons returned to the original point of capture and mortality of the relocated raccoons approached 50% during the first 3 months following release.

INTRODUCTION

Raccoons (*Procyon lotor*) are considered a pest in many city areas of southern Ontario (Rosatte 1986). Damage to lawns, gardens, residential roofs, chimneys and structures such as sheds and garages are commonly reported. There is also the potential for transmission of infectious diseases from raccoons to humans as well as to other animals (Wright 1977; Jacobson et al. 1982; Isaza and Courtney 1988).

Annually, more than 2000 "problem raccoons" are handled by the local Humane Society and animal control departments in the city of Toronto alone (Rosatte unpubl.). The dilemma is just what to do with those animals. Should they be euthanized, translocated to another locality, or should an investigation be initiated to establish methods to reduce human/raccoon interaction such as the design of predator-proof garbage containers. In many cases, the problem animals in Toronto are live-trapped, transported, and released in other areas. However, no follow-up has ever been carried out to determine the fate of those animals or establish that they did not return to the original capture site.

In 1986, the Ontario Ministry of Natural Resources in cooperation with the Ontario Humane Society initiated a research project to determine the fate of "city raccoons" translocated to either rural areas or a town. The major objectives of the study were:

(a) to determine the humaneness of relocating "problem raccoons" to unfamiliar areas;

(b) to estimate the survival rate of relocated raccoons;

(c) to observe the extent of exploratory movements by relocated animals;

(d) to predict the potential for infectious disease transmission from relocated raccoons to humans, domestic animals and wildlife;

(e) to determine whether translocated raccoons would return to the original capture site.

The following is a summary of the project results.

MATERIALS AND METHODS

Twenty-four raccoons (13 juveniles, 11 adults) were live-trapped (Tomahawk #106 - sardines as bait) in an urban area of Metropolitan Toronto between August 4 and October 1, 1986. The animals were immobilized with a mixture of ketamine hydrochloride and xylazine hydrochloride (10:1 ratio, 30 mg/kg ketamine), ear tagged for identification, weighed, measured and fitted with an adjustable radio-collar (Lotek Engineering, Aurora, Ontario - 151.309-151.467 MHz). They were also vaccinated against rabies with an intramuscular injection of Imrab inactivated rabies vaccine (Mérieux) and administered 0.5-1.0 ml of tetracycline to combat infection. Collared raccoons were then transported between 25 and 45 km north

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of Metro Toronto and released in a rural setting or in close proximity to a town (fig. 1). Groups of 3-5 animals were released at weekly intervals between August 7 and October 1. Attempts were made to locate the collared animals 5 times/week until winter denning began in December. Animals with neck circumferences less than 24 cm were recaptured periodically and collars adjusted to accommodate growth. Collars were removed at the end of the study. Signals from the transmitters were monitored using a Trackfinder TFR-1000 receiver and a truck-mounted 3-element Yagi antenna. Grid locations were tabulated to the nearest 100 metres using triangulation of compass bearings and entered on a PDT-RT11 computer for data analysis. Home range was calculated using the Minimum Area method with a RADTRAC program designed by Queen's University (Voigt and Tinline 1980). Home range or area utilized by the collared raccoons was determined for the initial exploratory movement period and also immediately following that time until winter denning. The exploratory movement period was assumed to be complete when nightly movements were < 1 km. Calculated home range is also a minimum estimate

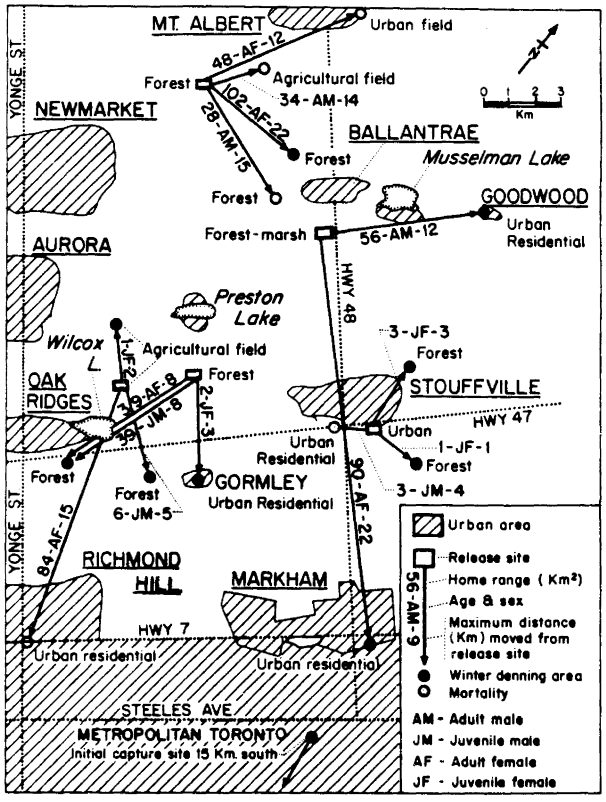

Figure 1. Release site and winter denning area of relocated urban raccoons.

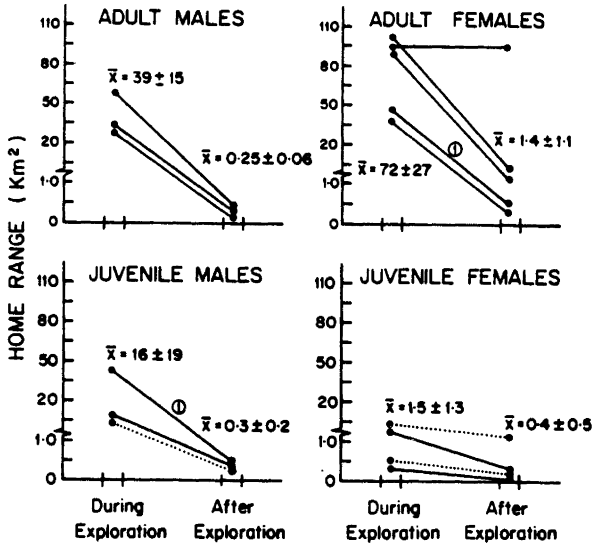

Figure 2. Home range of relocated raccoons during and after the exploratory movement period. ① - adult female and juvenile male travelled and denned together. •.....• town release site raccoon

as locations were taken during the day when the animals were resting. No doubt a greater area would have been covered while they were active during the evening. For lack of a better term in defining the area utilized during the exploratory period, "home range" will be used in the text. Differences in home range and dispersal per age/sex class were tested using a 2-sample *t*-test (Zar 1974). Directional bias during dispersal was tested using critical values of *r* for a circular distribution derived from Rayleigh's Z values (Zar 1974). Significance was set at $p < 0.05$.

RESULTS

Sufficient data were gathered on 15 of the 24 collared raccoons for movement and home range analysis ($\bar{x}$ = 39 different fixes/animal). Those animals were monitored a mean period of 75.2 days (35-71, non consecutive) using 581 locations.

On the average, the collared raccoons explored for 27.7 days (range 9-47) before settling into a well-defined home range. Exploratory movements were generally between 2-7 km/night, while post exploratory movements were less than 1 km/night.

Home range of relocated raccoons

The home range or area utilized while exploring after release was greater for adult raccoons than juveniles ($p < 0.001$). However, after exploratory movements had ceased, we could find no differences in home range between age/sex classes ($p < 0.5$) (fig. 2). Adult home ranges were greater while exploring than after settling down ($p < 0.002$); however, we could find no differences in juvenile home ranges during and after the exploratory period ($p < 0.5$) (fig. 2).

Home ranges of raccoons transplanted to the town were smaller than those released in rural settings during the exploratory period (p <0.05) (figs. 2, 3). However, we could find no difference after the exploratory period had ceased (p <0.5) (figs. 2, 3).

Movements by relocated raccoons

Maximum straight line distance across the perimeter of the home range was greater for adults than juveniles (p <0.001) (fig. 4). As well, the perimeter distance was greater for raccoons released in rural habitats than those released in the town (p <0.05) (fig. 4).

The maximum distance moved from the release site and the distance raccoons settled from the release site was greater for adults than juveniles (p <0.001) and greater for rural releases than the town releases (p <0.05) (fig. 4). However, we could find no differences between age/sex classes, town or rural releases for distances between the original urban capture site and the area where the relocated raccoons settled down (p <0.1) (fig. 4).

Directional movement bias

The mean angle of dispersal for all raccoons from the release site to the winter denning area was 148°, a S.S.E. directional drift. However, the drift was not biased to any specific direction (p >0.05, r = 0.330) (fig. 5). The mean angle of drift following release for age/sex cohorts was: adult males - 99°, adult females - 194°, juvenile males - 229°, and juvenile females - 78° (fig. 5). Directional drift for the different cohorts was not biased to any specific compass direction (p >0.05, r = 0.269-0.834).

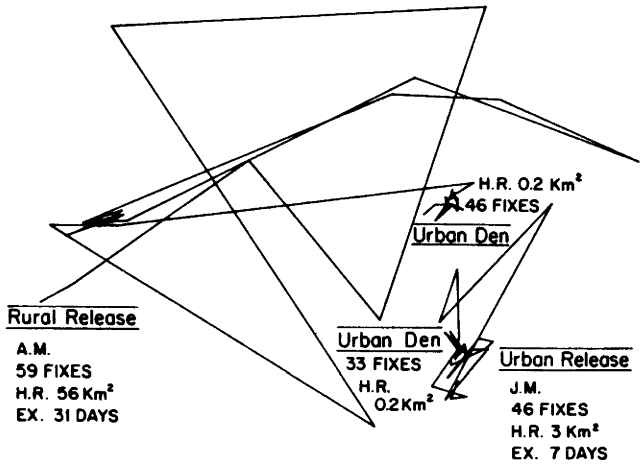

Figure 3. Home range of a rural and a town release site raccoon during and following the exploratory movement period.
H.R. = home range; A.M. = adult male; J.M. = juvenile male; E.X. = exploratory period. Urban Release = town release

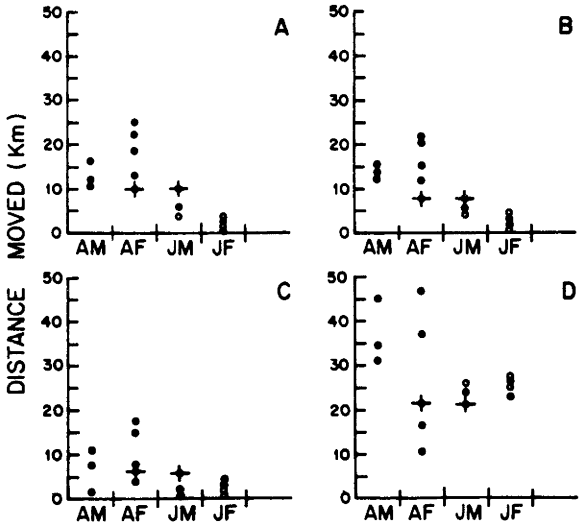

Figure 4. Distances moved by relocated raccoons following release.
A = maximum distance across home range perimeter
B = maximum distance moved from release site
C = distance settled from release site
D = distance settled from original capture site
o = town release site raccoon
• = rural release site raccoon
+ = juvenile male and adult female travelled together
A.M. = adult male A.F. = adult female
J.M. = juvenile male J.F. = juvenile female

Mortalities

Of the 24 relocated raccoons, 50% (12/24) succumbed within 3 months of release. Sources of mortality included shooting (5), road-kills (4), dogs (2) and poison (1). Three additional animals were possible mortalities as they could not be located despite live-trapping efforts, aerial and ground searches covering a 4500 km² area. However, we could find no difference in survival for animals released in the town (3/5) versus rural areas (10/19) (p >0.95).

The physical condition of some individuals was very poor when recaptured in the fall. One adult and two juveniles actually lost weight during the period when they should be storing fat for the winter denning period. In fact, October-November weights of 3 juveniles were 1-3 kg (30-50%) below the mean fall weight of urban juvenile raccoons from the same capture site during a previous study (Rosatte et al. 1987) (fig. 6).

Post exploration locations

Following the exploratory period, 60% (9/15) of the raccoons settled a mean distance of 0.3 km (range 0-1) from a town. The remaining 40% (6/15) settled in forested rural areas an average of 3.0 km (2.1-4.3) from a town. None of those animals were ever located in a town. However, of the animals settling in or in close proximity to towns, 45% of their locations during the tracking period were in towns, mainly residential areas. For the whole tracking period, the 15 raccoons were located in mature deciduous forest 40% of the time, in residential areas 26% and in agricultural fields (mainly standing corn) 34% of the time. They settled into a combination of different habitats including urban residential, forest, agricultural field and urban field (fig. 1). Winter denning sites within those habitats included trees, open chimneys, abandoned barns and sheds.

DISCUSSION

Relocation of raccoons in North America is not a recent wildlife management practice. Since the early 1950's raccoons were trapped and relocated throughout different localities of South Carolina (Frampton and Webb 1974). As well, thousands have been transported from south Florida to Kentucky and Virginia for hunting purposes (Wright 1977; Jenkins and Winkler 1987). In Ontario, as raccoon populations are quite high, most relocations are due to human/animal conflicts and are termed nuisance relocations. During this project, we attempted to examine the fate of city raccoons relocated either to rural areas or a town. The foremost finding was the exceptional exploratory movement period undertaken

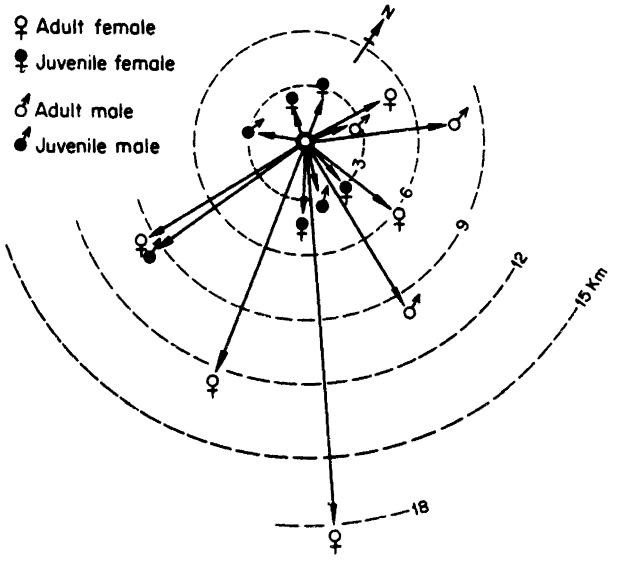

Figure 5. Directional drift by relocated raccoons following release.

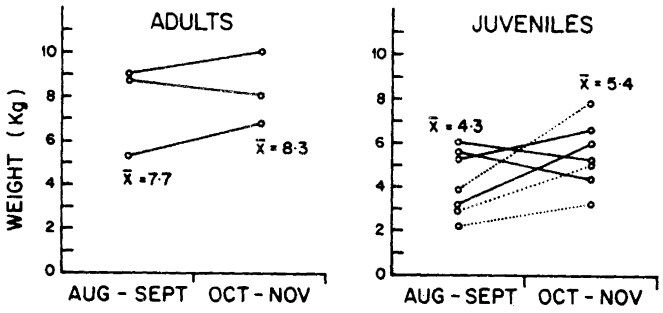

Figure 6. Weight gain/loss of relocated raccoons at the time of release and upon recapture.
o.....o town release site raccoon

by most of the radio-collared animals following release. Nightly forays of 2-7 km straight-line distance was common. Those movements were many times greater than annual movements made by radio-collared raccoons from the same initial capture site in Toronto ($\bar{x}$ = 0.8 km)(Rosatte et al. 1987). As well, home ranges during the exploratory period were exceptional when compared to those of urban raccoons in other cities. Annual ranges of 0.05 - 0.8 km^2 were common for raccoons in Washington, D.C., Cincinnati and New Brunswick, New Jersey (Cauley and Schinner 1973; Hoffmann and Gottschang 1977; Sherfy and Chapman 1980; Slade 1985). Mean annual home ranges for raccoons in the same initial capture site in Toronto were 0.42 km^2 (Rosatte et al. 1987).

The exceptional movements and extensive areas utilized by the relocated raccoons were possibly a result of disorientation through introduction to an unfamiliar environment. That hypothesis is supported by the fact that raccoons released at rural sites moved much greater distances than those released in a town. Once the animals became adjusted to their new habitat, home ranges compared well to raccoons in urban areas.

Disorientation is further supported in that none of the raccoons returned to the original capture site and there was no directional bias in movement following release. That suggests that raccoons do not possess any homing tendencies. Other researchers have also suggested that raccoons have no preference for direction or homing instinct when relocated (Frampton and Webb 1974).

The major concern with large exploratory movements by animals following relocation is the potential for the transmission of infectious diseases. A major epizootic of raccoon rabies in the mid-Atlantic U.S. during the 1980's was attributed to the translocation of raccoons from southern Florida to Virginia (Jenkins and Winkler 1987). As well, in Ontario during the late 1970's, an outbreak of rabies in skunks (*Mephitis mephitis*) was traced to the transplanting of nuisance animals from Mississauga

to Malton, both suburbs of Metropolitan Toronto (D. H. Johnston unpublished). The potential problem with relocation of wildlife is that the animal may be incubating an infectious disease while not exhibiting any clinical symptoms. The authors found a high percentage (55-60) of raccoons in Metro Toronto were serum positive for antibodies against canine distemper and feline panleukopenia. Raccoons have also been diagnosed with rabies, pseudorabies, *Baylisascaris procyonis*, canine parvovirus, canine distemper and canine adenovirus (Jacobson et al. 1982; Cranfield et al. 1984; Thawley and Wright 1982; Rabinowitz and Potgieter 1984; Dubey 1982; Rosatte 1988).

The humaneness of relocating urban raccoons must also be questioned. Mortality within the first 3 months of release was at least 50% and may have been as high as 75% due to the poor condition of some juveniles entering the winter denning period. Annual mortality in a sample (12) of radio-collared raccoons in Metro Toronto was less than 20% (Rosatte et al. 1987). Would it be more humane to euthanize the problem animals at the time of initial capture, or subject them to disorientation, starvation and mortality by dogs, automobiles, poison and shooting?

Another potential problem of relocating urban raccoons is the transfer of the problem from one locality to another. Most farmers in our area of relocation were exceptionally negative with respect to moving raccoons onto their farmland. Their major objections were due to past experiences with crop and building damage due to raccoons, as well as feces in grain storage bins and concern over the potential for disease transmission to their domestic stock. In our case, relocation of problem raccoons only resulted in shifting the human/wildlife interaction from the city to the country.

Solutions

The large number of human/raccoon conflicts in Metropolitan Toronto are due to high population densities of raccoons in some habitat types (Rosatte et al. 1987). Solutions to the conflict could include lowering the population density of raccoons in the problem area. That could be accomplished by:

a. the use of reproductive inhibitors or chemical sterilants in baits to render adult and juvenile female raccoons infertile (Howard 1967; Johnston et al. 1988; Kirkpatrick and Turner Jr. 1985);

b. the surgical sterilization of adult male raccoons following live-capture (Bojrab 1986);

c. euthanize problem raccoons following capture.

Probably the most effective method of alleviating the problem of nuisance raccoons is by exclusion. Many problems could be avoided simply by screening off chimneys and sealing all access to garages, sheds and barns. Predator-proof electric fences can be erected around gardens or an even cheaper method is to employ a watch-dog. If the only solution is to transplant, then if at all possible the animals should be vaccinated with a licensed vaccine to avoid the transmission of infectious diseases.

In conclusion, we do not recommend relocation of urban raccoons to solve nuisance problems as the potential for disease transmission due to large exploratory movements is high. As well, the humaneness of the technique has to be questioned due to high mortality rates and severe weight loss in juveniles.

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LITERATURE CITED

Bojrab, J. 1986. Current techniques in small animal surgery. p. 375-376. Lee and Sebiger, Philadelphia, Pa.

Cauley, D. L. and J. R. Schinner. 1973. The Cincinnati Raccoons. Nat. Hist. 82:58-60.

Cranfield, M. R., I. K. Barker, K. G. Mehren and W. A. Rapley. 1984. Canine distemper in wild raccoons (*Procyon lotor*) at the Metropolitan Toronto Zoo. Can. Vet. J. 25:63-66.

Dubey, J. P. 1982. *Baylisascaris procyonis* and eimerian infections in raccoons. J. Am. Vet. Med. Assoc. 181:1292-1294.

Frampton, J. E. and L. G. Webb. 1974. Preliminary report on the movement and fate of raccoons released in unfamiliar territory. p. 170-183. *In* Proceed. 27th Conference S.E. Assoc. of Game and Fish Commissioners. A. L. Mitchell (ed). Hot Springs, Arkansas.

Hoffmann, C. O. and J. L. Gottschang. 1977. Numbers, distribution and movements of a raccoon population in a suburban residential community. J. Mammal. 58:623-636.

Howard, W. E. 1967. Biocontrol and chemosterilants. p. 343-386. *In* Pest Control. W. W. Kilgore and L. Douth Jr. (eds). Academic Press, N. Y.

Isaza, R. and C. H. Courtney. 1988. Possible association between *Dirofilaria tenius* infections in humans and its prevalence in raccoons in Florida. J. Parasit. 74:189-190.

Jacobson, J. E., K. R. Kazacos and F. H. Montague Jr. 1982. Prevalence of eggs of *Baylisascaris procyonis* in raccoon scats from an urban and a rural community. J. Wildl. Dis. 18:461-464.

Jenkins, S. R. and W. G. Winkler. 1987. Descriptive epidemiology from an epizootic of raccoon rabies in the middle Atlantic States, 1982-1983. Amer. J. Epid. 126:429-437.

Johnston, D. H., D. R. Voigt, C. D. MacInnes, P. Bachmann, K. Lawson and C. Rupprecht. 1988. An aerial baiting system for the distribution of attenuated or recombinant rabies vaccine for foxes, raccoons and skunks. Rev. of Infect. Dis. 10:660-664.

Kirkpatrick, J. F. and J. W. Turner Jr. 1985. Chemical fertility control and wildlife management. Bioscience 35:485-491.

Rabinowitz, A. R. and L. N. D. Potgieter. 1984. Serologic survey for selected viruses in a population of raccoons, *Procyon lotor* in the Great Smokey Mountains. J. Wildl. Dis. 20:146-148.

Rosatte, R. C. 1986. Preliminary studies on the feasibility of urban rabies control. p. 78-91. *In* Proceed. 7th Great Plains Wildl. Dam. Cont. Work. D. B. Fagre (ed). Agric. Comm., Texas A & M Univ. publ. College Station, Texas.

Rosatte, R. C. 1988. Rabies in Canada: History, Epidemiology and Control. Can. Vet. J. 29:362-365.

Rosatte, R. C., P. M. Kelly-Ward and C. D. MacInnes. 1987. A strategy for controlling rabies in urban skunks and raccoons. p. 161-167 *In* Integrating Man and Nature in the Metropolitan Environment. L. W. Adams and D. L. Leedy (eds). Publ. by Natl. Inst. for Urban Wild., Columbia, MD.

Sherfy, F. C. and J. A. Chapman. 1980. Seasonal home range and habitat utilization of raccoons in Maryland. Carnivore 111(3):8-18.

Slade, D. 1985. Movement, activity and home range patterns among members of a high density suburban raccoon population. Ph.D. dissertation, Rutgers Univ. New Brunswick, N.J. 112 pp.

Thawley, D. G. and J. C. Wright. 1982. Pseudorabies virus infection in raccoons: A Review. J. Wildl. Dis. 18:113-116.

Voigt, D. R. and R. R. Tinline. 1980. Strategies for analyzing radio-tracking data. p. 387-404. *In* A handbook on biotelemetry and radio-tracking. C. J. Amlaner Jr. and D. W. Macdonald (eds). Oxford.

Wright, G. A. 1977. Dispersal and survival of translocated raccoons in Kentucky. p. 285-294. *In* Proceed. 31st Conf. S.E. Assoc. of Fish and Wildl. Agencies. R. W. Dimmick (ed). San Antonio, Texas.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall Inc. Englewood Cliffs, N.J. 620 pp.