Assessment and preliminary development of the rotating-jaw Conibear 120 trap to effectively kill marten (*Martes americana*)

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Testing and development of the commercially available rotating-jaw Conibear 120 (C120) trap were conducted from January to June 1986 with wild marten (*Martes americana*) in simulated natural environments. Minimizing the pain and suffering of animals was a primary concern throughout the entire investigation. Through a series of approach tests involving traps wired in the set position, a pitch-fork style trigger was developed which enabled the trap to consistently strike animals in the head and neck region. The ability of the C120 to effectively kill marten was first assessed in preselection tests in which anaesthetized animals were placed in the trap in a position that duplicated the finding of the approach tests. Five out of six animals were rendered unconscious within 3 min. Thereafter, the ability of the C120 to effectively kill unanaesthetized marten was tested against that of a prototype, the C120 Mark IV, a more powerful modified version of the original model. The C120 failed to render unconscious at least five out of six unanaesthetized marten within 3 min and, by protocol, was rejected as an effective killing trap. The C120 Mark IV, with a metal bar welded on the top striking jaw, rendered five out of six marten unconscious within 3 min and qualified for further testing as a potentially effective trap to kill marten. Despite its wide use as a quick-kill trap, the C120 did not meet the performance criteria of this study. The mechanically upgraded C120 Mark IV outperformed the C120 but further improvements are needed to ensure consistently quick kills with marten.

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Le piège commercial rotatoire Conibear 120 (C120) a été étudié de janvier à juin 1986 chez des martres (*Martes americana*) sauvages dans des environments semi-naturels. Le programme de recherche a été conçu de façon à réduire au minimum la douleur et la souffrance chez les animaux. Dans des études d'approche où les pièges ne pouvaient pas se refermer complètement, une détente en forme de fourche a été conçue pour capturer les animaux toujours par la tête ou le cou. La capacité du piège C120 de tuer rapidement les martres fut tout d'abord déterminée dans des tests de pré-sélection où des animaux anesthésiés ont été placés dans les pièges dans une position identique à celle determinée lors des études d'approche. Cinq animaux sur six ont perdu conscience en moins de 3 min. Puis, la capacité du piège C120 de tuer rapidement des martres non-anesthésiées fut comparée à celle d'un prototype, le C120 Mark IV, une version plus puissante du modèle original. Le piège C120 n'a pas réussi à rendre inconscient en moins de 3 min au moins cinq des six martres non-anesthésiées et, selon le protocole de recherche, il fut rejeté. Le piège C120 Mark IV muni d'une barre de métal soudée sur sa mâchoire supérieure, a rendu inconscient en moins de 3 min cinq martres sur six. Ce piège a le potentiel de tuer rapidement les martres et se qualifie pour des études ultérieures. Malgré sa grande utilisation et sa réputation de tuer rapidement, le piège C120 n'a pas rencontré les critères d'acceptation de cette étude. Le piège C120 Mark IV, quoiqu'il soit supérieur d'un point de vue mécanique, devrait être perfectionné davantage pour assurer toujours une mort rapide des martres.

Introduction

Since 1960, the rotating-jaw Conibear 120 (C120) trap (Woodstream Co., Niagara Falls, Ontario) has been used throughout Canada in response to a growing public concern about the cruelty of trapping methods (Federal Provincial Committee for Humane Trapping 1981; Gerstell 1985). It is presently considered to be the state-of-the-art trapping device to harvest marten (*Martes americana*). It is also believed to be a quick-kill device that renders animals unconscious instantly (Standing Committee on Aboriginal Affairs and Northern Development 1986) and its use is taught in trapping and conservation manuals (Canadian Trappers Federation 1984; Alberta Energy and Natural Resources 1985). However, Gilbert (1981*a*) found that it was difficult to position the animal properly in the trap with the present trigger system and that the striking bars did not always strike the animals in vulnerable areas such as the head and neck region. Furthermore, based on kill threshold standards (Canadian General Standards Board 1984), the impact and clamping energies of the C120 are not high enough to kill marten effectively (Cook and Proulx 1989).

Cook and Proulx (1989) found that the impact and clamping forces of the C120 could be increased by welding a metal bar to the striking jaws (a modification adopted by the Federal Provincial Committee for Humane Trapping (1981) upon recommendation by trapper R. Lancour and the British Columbia Trapper Association) and replacing the factory springs with stronger ones. However, their prototype, the C120 Mark IV (Cook and Proulx 1989) has not been tested before now with animals.

In response to a societal concern about animal welfare and because of the uncertainty surrounding the ability of the C120 to kill marten quickly, a study was conducted with the following objectives: (*i*) to develop a trigger to properly position marten in the C120; (*ii*) to assess the ability of the C120 to kill marten effectively in laboratory conditions, with anaesthetized animals; (*iii*) to assess the ability of the C120 to kill unanaesthetized marten effectively under simulated natural conditions; (*iv*) to assess the killing effectiveness of the C120 Mark IV.

Materials and methods

The study was conducted in a 2.2-ha forested compound at the Alberta Environmental Centre, in Vegreville, Alberta. The compound included holding facilities and test enclosures, and a building with a laboratory and video room.

Animals and husbandry

Wild marten were captured in November and December 1985 by Yukon and Alberta registered trappers using National live traps (Tomahawk Livetrap Co., Tomahawk, Wisconsin). Animals were housed individually in a two-chambered nest box (61 × 51 × 41 cm) attached to a 2.5-cm wire mesh holding pen (1.0 × 0.6 × 0.5 m) set outside on a platform surrounded by a deciduous forest. Marten were fed 150–200 g of commercial ranch mink feed daily. Holding facilities were cleaned once a week. After at least 1 month in the holding pens, martens were transferred, one at a time, to one of three test enclosures (12.2 × 5.2 × 4.4 m) landscaped with vegetation (sod, deciduous and coniferous bushes, large deciduous trees, dead branches and logs). Marten were allowed a minimum of 3 days to acclimate to the simulated natural environment before any tests were conducted.

Traps

The C120 trap consisted of two 11.9 × 11.9 cm metal frames hinged at their center point to operate in a scissor-like action, and equipped with two torsion springs (11.4 cm, 4.3 i.d. coil) made of 0.41-cm wire (Fig. 1*a*). The C120 Mark IV differs from the C120 in having its springs made of larger wire (0.53-cm) and by the presence of two rectangular bars (7.62 × 1.27 × 0.28 cm) welded on the same frame, on opposite jaws (Fig. 1*b*). When the trap is sprung, only one bar comes in contact with the animal and, depending on how the trap is set, it can strike the animal from either the top or the bottom.

Research protocols

Minimizing the pain and suffering of animals was a primary concern throughout the entire investigation. Also, we aimed to minimize the use of live animals and, therefore, to conform with the policy of the Alberta Society for the Prevention of Cruelty to Animals on the experimental use of animals. A test sequence was designed to ensure efficient use of animals and a thorough evaluation of the killing devices. We felt that with a minimum of five out of six successful repetitions per category of testing (described below) we could identify traps with the potential to effectively kill marten.

Approach tests (16 January – 6 March 1986)

Animals were allowed to approach traps wired in the set position so that the traps could be triggered but would not close completely and injure the animals. These tests corresponded to the first objective and assessed the ability of traps to strike marten in an appropriate location, i.e., in the head and neck region (Gilbert 1981*a*).

As recommended by professional trappers, traps were boiled, dyed, and waxed; they were set in a box (35 × 17 × 17 cm) made of plywood and Plexiglas (to allow the events to be recorded) and closed at one extremity by a 2.5-cm wire mesh. The traps were placed in the front of the box with the springs set 10 cm away from the back of the side slots so that the trap would not jump forward when fired (Fig. 2). The bait consisted of the daily commercial ration placed 12 cm behind the center of the trap.

Marten approaches were recorded with two remote control Panasonic WV1854 videocameras equipped with a Comiscar 15- to 180-mm f/1.9 1500 lens and a high efficiency 500 W infrared (invisible to animal eyes) light illuminator (Avicom Industrial Communications, Edmonton, Alberta). Each camera was connected to an AG-6010 Panasonic videorecorder equipped with a date and time generator (Avicom Industrial Communications, Edmonton, Alberta).

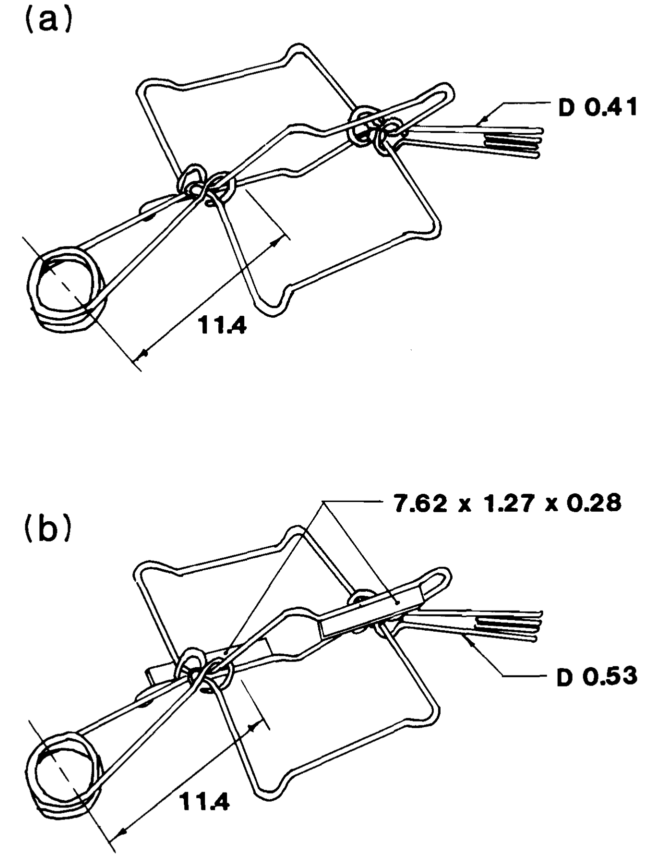

FIG. 1. Diagram of the Conibear 120 (*a*) and the C120 Mark IV (*b*). All diagram dimensions are in centimetres.

The actual time of trap firing was denoted by release of the trigger. The videotapes were analyzed frame by frame with two NV-8500 Panasonic VHS editing recorders (Avicom Industrial Communications, Edmonton, Alberta). By projecting the arc movement of the striking bars on the marten, it was determined where the animal would have been struck had the trap been allowed to close completely.

The development of an adequate trigger was first done empirically with marten approaching traps with different trigger configurations. Once a configuration showed some potential, it was tested with naive animals (i.e., ones that presumably had never approached a Conibear trap before). A trigger configuration was judged acceptable if animals were successfully placed in at least five of six approaches.

Preselection tests (3–7 April 1986)

Six traps of the model that passed the approach tests were used to kill six marten (those used in the approach tests) immobilized with ketamine HCl (10–20 mg/kg) (Austin Laboratories, Joliette, Quebec) or a 10:1 mixture of ketamine HCl – xylazine (0.2 mL/kg) (Haver-Lockhart, Miles Laboratories Ltd., Rexdale, Ontario). These tests assessed the ability of traps to kill anaesthetized marten effectively and fulfilled the second objective.

Anaesthetized animals were propped up on a platform, ventral side down, with the head projecting over the edge. A thread stitched through loose skin on the top of the nose was used to guide the animal into the trap in a position that duplicated placement in the approach tests. The trap, solidly secured by its springs to two support rods, was fired by pulling the trigger with a string. All tests were video-recorded.

Traps were considered to be potentially effective if they rendered at least five of six animals unconscious, with inevitable subsidence into death (determined by loss of cardiac activity), within 3 min (the

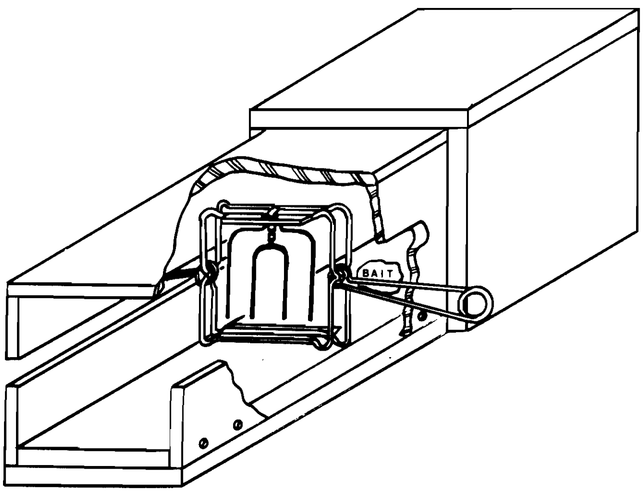

FIG. 2. Trap in a cubby set.

research upon which the Canadian General Standards Board (1984) based its kill threshold standards used a 3-min test period to unconsciousness). Unconsciousness was diagnosed by the loss of the corneal and palpebral reflexes (Walker 1979; Horton 1980; Rowsell *et al.* 1981).

Kill tests (21 April – 16 June 1986)

Six traps of the model that passed the preselection tests were used to kill six naive marten. These tests fulfilled the third objective and assessed the ability of traps to effectively kill unanaesthetized animals entering a trap set in a manner identical with those in approach tests.

All kill tests were recorded with two videocameras. Observers monitored the kills from the video room and, upon firing of the trap, ran approximately 125 m to the test enclosures to monitor the state of consciousness of the animals. Traps were considered to be effective if they successfully rendered at least five of six animals unconscious, with inevitable subsidence into death, within 3 min.

During preselection and kill tests, animals correctly struck but still conscious after 3 min were left in the trap for an additional 2 min at which time they were killed by an intrathoracic injection of 540 mg/mL sodium pentobarbital (euthanyl forte, M.T.C. Pharmaceuticals, Cambridge, Ontario). Animals were necropsied by a veterinary pathologist.

All procedures were carried out in accordance with the Guidelines of the Canadian Council of Animal Care. Protocols for the kill tests were referred to the Council for their review before implementation.

Results

Approach tests and trigger development

Preliminary work

On two attempts, a four-pronged trigger with a fountain configuration was unsuccessful in properly positioning marten 69 in a C120 (Figs. 3*a*, 3*b*). In the first approach, with the prongs extending from the proximal bottom jaw (Fig. 3*a*), the animal fired the trap with its foreleg, which interfered with the movement of the lower striking bar. In the second approach the prongs extended from the proximal top jaw (Fig. 3*b*). The animal pushed the trigger prongs with its nose and quickly jerked backwards as the trap fired. As a result of the acute angle of the animal's head to the trap frame, the upper striking bar would have shaved the skull while the lower one would have tapped the tip of the animal's nose (Fig. 3*b*).

Marten 69 tended to approach the largest trap opening, at the apex of the trigger (Figs. 3*a*, 3*b*). In the third approach, prongs were bent differently to center this opening (Fig. 3*c*). This trigger configuration adequately positioned marten 69 and the striking bars would have moved freely and hit the animal's head (Fig. 3*c*). A second test with this trigger using a naive animal (marten 70) was unsuccessful because the marten fired the trap with its paw (Fig. 3*d*).

The pitch-fork configuration was the next trigger evaluated (Fig. 3*e*). This configuration eliminated all horizontal segments upon which the animal could rest its paw. The largest trap opening was kept at the center, where the prongs were 42 mm apart; the outside prongs were kept equidistant from the center ones and the trap frame (Fig. 3*e*). The first approach was successful. Marten 70 fired the trap by pushing its nose between the center prongs (Fig. 3*e*). This would have resulted in a double strike in the head and neck region with the forelegs clear of the arc movement of the striking bar. This trigger configuration was selected for a complete series of approach tests.

The 42-mm pitch-fork trigger

Four animals would have been hit on the skull. A fifth approach would have resulted in a double strike when an animal succeeded in entering the trap farther by squeezing between the center prongs. However, the double strike would have occurred entirely in the head and neck region and the approach was judged successful. One marten avoided the center prongs of the trigger by tilting its head sideways, and fired the trap with its shoulders. This resulted in a double strike on the skull and the thorax, which was judged unsuccessful. All animals but one directed their approach towards the lower half of the trap.

The 30-mm pitch-fork trigger

To obtain greater consistency and to ensure that animals fired the trap with the anterior portion of their head, a further complete series of approach tests was conducted with the distance between the center prongs of the trigger reduced to 30 mm. All six approaches by naive animals were successful: two animals would have been struck on the top of the skull and four in the skull and neck area. In one approach, the trap would have hit a marten on the skull and slapped its left paw. However, the paw was almost parallel to the jawbone and the lower striking bar would have hit the skull and the toes almost simultaneously. It is unlikely that this interference by the left paw would have reduced the velocity of the striking bar. All six animals directed their approach towards the center lower half of the trap.

Preselection tests

The average time to loss of corneal reflex in anaesthetized animals in five successful preselection tests with a C120, in which the upper striking bar hit the animals on the posterior portion of the skull or the skull–neck junction area, was estimated at 6.8 (± 4.1 (SD)) s after the trap was fired (Table 1). A time lapse occurred between the assessments of the corneal and palpebral reflexes. The average loss of the palpebral reflex was <25.6 (± 12.8) s after the trap was fired. The heartbeat was lost, on average, 169.0 (± 54.0) s after the trap was fired (Table 1). In all five cases, multiple skull fractures and extensive hemorrhages in the brain region were recorded. In the unsuccessful test, the upper striking bar struck the animal anterior to the ears. The animal lost consciousness 5 min 13 s after the firing of the trap and neither skull fracture nor brain hemorrhage was found. The trap successfully passed (five out of six) the preselection tests.

The C120 Mark IV was more powerful than the Conibear

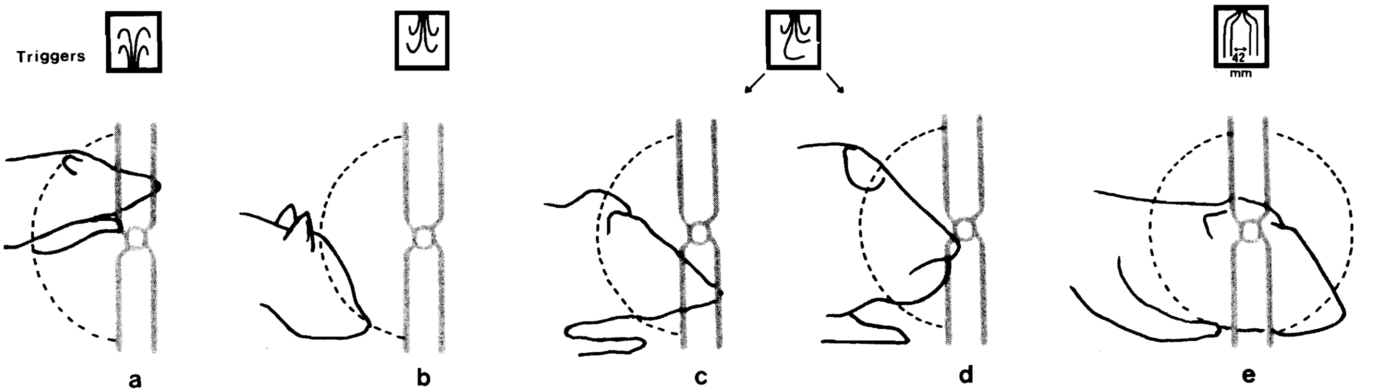

FIG. 3. Position of marten in approach tests, at time of firing, with the Conibear 120 and different trigger configurations. See text for further explanation.

TABLE 1. Location of strike and time interval between trap firing and irreversible loss of corneal and palpebral reflexes and heartbeat of marten in preselection (anaesthetized) and kill (nonanaesthetized) tests with Conibear 120 traps

		Time (s) to loss after trap firing		
Marten No.	Location of strike	Corneal reflex	Palpebral reflex	Heartbeat
	Preselection tests			
76	Posterior portion of skull	14	38	197
64	Posterior portion of skull	6	21	106
13	Posterior portion of skull	5	40	198
11	Posterior portion of skull	4	11	227
14	Neck (C_1-C_2)	5	18	117
63	Anterior portion of skull	313*	329	>360†
	Kill tests			
86	Atlanto-occipital joint	162		292
82	Atlanto-occipital joint	142		258
1	Posterior portion of skull	79		360
41	Neck (C_1)	123		276
85	Neck (C_2-C_3)	E		E
90	Neck (C_2)	E		E

NOTE: Corneal and palpebral reflexes were combined for the kill tests. E, killed by euthanasia.
*First signs of loss of consciousness recorded at 300 s.
†Exact time not recorded.

120 (Cook and Proulx 1989) and it was judged unnecessary to repeat the preselection tests with it.

Kill tests

Conibear 120

Four out of six animals were struck on the posterior portion of the skull or in the atlanto-occipital joint area (Table 1). Loss of corneal and palpebral reflexes occurred, on average, 126.5 (± 35.4) s after the trap was fired, a period significantly ($p < 0.05$) longer than that recorded for anaesthetized animals. Post-strike cardiac activity lasted, on average, 296.5 (± 44.6) s and was significantly ($p < 0.05$) longer than the time recorded during preselection tests. Trauma consisted mainly of discrete hemorrhages at trap impact site. Two marten were captured by the neck (C_2-C_3 vertebrae), and loss of consciousness did not occur within 5 min. These animals were killed with sodium pentobarbital. In both cases, neither bone fractures nor brain or dura hemorrhages were found. The C120 failed to render at least five of six marten unconscious within 3 min and, by protocol, was rejected as an effective trap to kill marten.

C120 Mark IV with metal bar welded on the bottom jaw

The average time to loss of corneal and palpebral reflexes in four successful kill tests, in which the upper striking bar struck the animals on the skull or in the atlas area, was estimated at 118.3 (± 22.7) s after the trap was fired (Table 2). Post-strike cardiac activity lasted, on average, 234.0 (± 53.1) s. These averages were not significantly different ($p > 0.05$) from those estimated with the C120. On two occasions, trauma was superficial or nonapparent. Two animals did not lose consciousness within 5 min and were killed with sodium pentobarbital (Table 2). The C120 Mark IV with the contacting metal bar on the bottom jaw did not render at least five of six marten unconscious within 3 min and was rejected.

C120 Mark IV with metal bar welded on the top jaw

The first five kill tests were successful and loss of con-

TABLE 2. Location of strike and time interval between trap firing and irreversible loss of corneal and palpebral reflexes and heartbeat of marten in kill tests with C120 Mark IV

Marten No.	Location of strike	Time (s) to loss after trap firing: Corneal and palpebral reflexes	Heartbeat
	Welded bar on bottom jaw of the trap		
42	Atlanto-occipital joint	150	305
40	Anterior to the ears	96	184
37	Neck (C_1-C_2)	113	242
36	Atlanto-occipital joint	114	205
38	Neck (lateral blow, C_3)	E	E
78	Atlanto-occipital joint	E	E
	Welded bar on top jaw of the trap		
30	Atlanto-occipital joint	177	376
29	Top of skull	106	256
72	Top of skull	<54*	267
70	Anterior to the ears	<50*	425
35	Neck (C_2)	156	286
77	Atlanto-occipital joint	E	E

NOTE: E, killed by euthanasia.
*Animal was unconscious upon arrival of the observer.

sciousness and heartbeat occurred on average 108.6 ($\pm$ 57.8) and 322 ($\pm$ 74.5) s, respectively, after the trap was fired. These averages were not significantly different ($p > 0.05$) from those estimated with the C120 and the C120 Mark IV with the contacting metal bar on the bottom jaw. Trauma varied greatly between marten and ranged from cranial and cervical fractures and brain hemorrhage to localized muscular hemorrhages. One marten struck on the atlanto-occipital joint did not lose consciousness within 5 min and was killed with sodium pentobarbital (Table 2). The C120 Mark IV with the contacting metal bar on the top jaw rendered at least five of six marten unconscious within 3 min and, by protocol, qualified as a potentially effective trap to kill marten.

Discussion

The ability of a trap to kill marten effectively cannot be assessed without a good understanding of the animal's behavior in relation to the trigger system. Gilbert's (1981*b*) approach tests with mustelids, particularly mink (*Mustela vison*), showed that it was possible to improve trap sets to obtain better strike locations but about 10% of approaches could still be expected to be unsatisfactory. The 30-mm pitch-fork trigger developed in this study successfully positioned all 18 marten in the C120 and the C120 Mark IV to induce strikes in the head and neck region. However, the trigger configuration was developed with animals that were used to taking their daily food ration through the mesh wire of their holding pens and, consequently, they may have been less wary than wild unrestrained animals in approaching and triggering a trap. Because the behavior of an animal in relation to the triggering mechanism is so vital in determining the utility of a trap (Cook *et al.* 1973), it may be necessary to make further trigger adjustments to capture wild, unrestrained marten.

The difference in time to the loss of consciousness between preselection and kill tests suggests that the preselection test results must be cautiously interpreted. A trap that renders anaesthetized animals unconscious within 3 min may not produce the same results with unanaesthetized animals. However, if a trap does not render anaesthetized animals unconscious within 3 min, it is unlikely to do so with unanaesthetized ones. The muscles of anaesthetized animals are more relaxed than those of unanaesthetized ones and offer less resistance to the striking bars. In addition, unanaesthetized marten were aware of what was happening to them and were "fighting" the trap.

Obviously, depending upon the criteria used, many traps could be classified as effective killing devices. On the other hand, the Federal Provincial Committee for Humane Trapping (1981) found that a maximum of 3 min to unconsciousness was a realistic criterion to identify traps that could effectively kill mink and marten. The C120 would be a potentially effective killing device by our research protocol if it consistently hit marten in the region extending from the ears to the C_1 vertebra. However, we believe it to be impractical and likely impossible to restrict the hits to an area smaller than the head and neck region because of the variation in the size of the animals, the manner and speed of their approaches, and the sensitivity of the trigger, which still varied between traps even after in-house adjustments. With respect to the commercial C120 trap, we conclude that under practical trapline use it is unlikely to have the inherent mechanical energies to consistently render marten unconscious within 3 min as per our research standards.

The C120 Mark IV with metal bar welded on the top jaw illustrates how the basic C120 model can be improved to kill marten more effectively. The pitch-fork trigger positions the animal's head low in the trap, the metal bar on the top jaw has greater displacement, and, because the larger springs produce increased velocity, it strikes with greater force. However, because it barely succeeded in rendering an animal hit on the atlanto-occipital joint unconscious within 3 min and failed in another instance, it is recommended that further work be carried out to enhance its impact and clamping forces and to further increase its killing effectiveness. Because of continued societal concern regarding trapping and identified deficiencies of existing traps available to trappers, work continues in our laboratory towards the development of improved devices.

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